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Cover Picture

This is a picture of a biology classroom in the Soviet Union. It accompanies the article by Professor Pettit in this issue.

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Biology Teaching in the Soviet Union*

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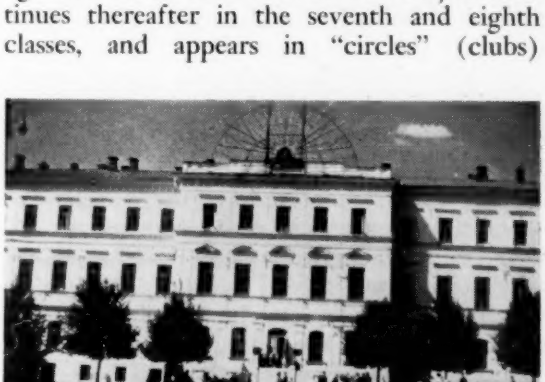
Department of Natural Science, Michigan State University

A five-weeks' visit to schools and universities in four major cities in the Soviet Union during August and September, 1958, has provided some observations which will interest biology teachers. The writer spent many hours in classrooms as a member of a delegation of the Comparative Education Society numbering seventy persons. The group met *en masse* with officials to get the broad outlines of the program, and then separated into small groups to spend full periods in classes at all levels and in all subjects, meeting afterwards to compare notes. Interpreters were provided by the Soviet Educational and Scientific Workers' Trade Union in part, and by our Society. Many of us had studied Russian sufficiently to read elementary textbooks and the gist of newspaper and other articles, and the writer was able to move freely in all four cities—Moscow, Kiev, Leningrad and Tashkent—without benefit of interpreters. Innumerable observations could be made without resort to translation of the language, but when essential to understanding, it was always possible to find one of our interpreters or an English-speaking Russian.

While it was understood from the start that we would see only the best schools, we felt—after the first two weeks or so of natural skepticism—that our hosts were unexpectedly frank and open in answering questions. We ceased to hunt for contradictions after a while, because those we thought we had detected proved to be errors of translation. We soon settled to gathering information about things we actually observed, deducting liberally for Soviet over-enthusiasm in their statements. The consensus of our delegation was surprisingly uniform, at the end of our experience, in deciding that we had not been duped since the great variety of things we saw would have to be part of a far more elaborate plan than the visit of our small group warranted.

As expected, the comprehensive plan of Soviet education is directed from the top. All phases of the system are directed toward promoting communism and advancing its progress throughout the world. There was no hesitancy whatever in telling us exactly this. The evidences of such a plan were everywhere to be seen. The educational system is competently managed to this end. Education is not the right of the freeborn, but an instrument of the state, industriously prodded, amply supplied with funds, exceedingly vigorous and ambitious, with an intensely patriotic and dedicated teaching staff of well-trained men and women. The dynamism of Soviet education is one of its outstanding features. While it is desirable to keep in mind the basic difference in the ideologies—the priority of the *state* in the U.S.S.R., and the primary concern for the development of the *individual as a person* in the United States—there are far more similarities than the visitor anticipates. And the energetic willingness of teachers to excel at their specialty in the U.S.S.R. is an astonishing rejection of the notion commonly believed in this country that the Russian people are slaves or are on the brink of revolt. Nothing could be further from the truth.

Biology in the classroom is entered upon earlier in Soviet schools than in our own. Two hours a week are devoted to biology in the fifth class (equivalent to our sixth grade). The subject is taught once again in the sixth class, again for two hours a week. The subject continues thereafter in the seventh and eighth classes, and appears in "circles" (clubs)



1. Public school at Kiev. City schools are well planned but of plain construction. This school houses ten grades. Biology is offered in their sixth (our seventh) grade and in subsequent grades as well.

*Departmental contribution No. 126.

2. Sixth grade (our seventh) pupils explain their drawings of the cell. Teacher pays close attention to whomever is reciting, but other pupils are relatively idle. This was considered a glaring weakness in classroom practice. The recitations of these prize students were well presented. Rote memorization is a prominent feature of education but is justified by saying knowledge is the basis for thought and discussion which comes later.

optional to the end of the ten-year school. In the circles, the pupils are supervised by their regular teacher, but when the circles meet together once a week for the regional activities, at the "Pioneer Palace," they have separate instruction in their chosen "hobby" by a special staff. This outside program is heavily financed as after-school work, solving the problem of juvenile delinquency to a large extent by keeping the pupils interested in worthwhile activities until suppertime. In the evenings, homework requires one and a half hours in the elementary school and gradually increases to three hours by the tenth year. Schools are in session six days a week (resulting in the equivalent of twelve years under our system). Children enter school a year older and leave a year younger.

Not many schools have been ten-year schools. Most are only seven-year schools. A year from now, a new system will be undertaken, with widespread effects. The eight-year school will be introduced, with ten-year schools available but not compulsory. Children will ordinarily leave school at the age of 15 or 16 but may continue their education evenings or by correspondence courses, or—for talented pupils in certain fields, such as music, dance, art, and mathematics—may gain their labor-experience by a kind of on-the-job training, while attending school a greater percentage of the time.

Biology is essentially an applied subject. Great store is set by practical work such as gardening, experiment station visits, and even experiment station practice, as at Kiev, where a large area with a special staff is devoted entirely to biology. Considerable attention is paid to agriculture, orchard management, and animal breeding. Classwork appears to be largely intensive memorization of innumerable facts, as is the case in other European countries.

The teachers we observed in the classroom were very well informed about their subject matter, but this was to be expected in their best schools and especially when one learns that the biology teachers (as is true of all teachers) have but one subject to teach.

In the seventh class (eighth grade) the emphasis was upon economic zoology at the time we visited the room. There were 28 pupils who heard about climate and food with relation to various animals, such as tigers,

3. Skeleton and charts, and models of human torso resemble those found in our schools. Microscopes are not common even in the best city schools we were shown.

whales, birds in general, and arctic birds in particular. Adaptation was also stressed. The teacher very frequently called upon pupils to stand and give supporting evidence for the teacher's generalities, and this was always done with promptness and evident knowledge and surprisingly good stage-presence and self-confidence. Always the topic under discussion was brought back to the importance of knowing animals in relation to the economics of the U.S.S.R.

The writer was particularly interested in the teaching of heredity and Darwinism and purchased a variety of books for study upon returning to the United States. The theory of genes is still rejected in the U.S.S.R., although a group of geneticists is supported outside Moscow under the leadership of Dubinin, who is an opponent of over emphasis of Lysenkoism. Lysenko has not diminished in

4. A biology teacher in Tashkent, Uzbekistan, Central Asia, proudly shows cotton plants of different varieties grown under varying conditions by his pupils. All schools we saw had school gardens. The "harvest" was on display as part of the activities of the biology classes. Volunteers care for the gardens in summer.

5. High school classroom with display of the results of gardening by pupils. The different yields arose by using different plant foods.
(Photo by Dr. Gabe Sanders)

influence, contrary to what has been supposed in this country. In fact, he stands higher than ever in his support of acquired characteristics. His name is very frequently mentioned in almost all textbooks, and his ideas are in close harmony with dialectical materialism, the political philosophy that distinguishes communism from other political philosophies.

Lysenko's picture appears in most biology classrooms. Considerable space is devoted to his methods of improving stocks of grains and fruits, and he is a national figure of great importance, partly because his methods have made important contributions to the production of millet, a grain which some believe had a major part in winning the war.

There is always a question in one's mind when observing the stress placed upon the practical aspects of biology in the schools. One wonders where the broadly trained scientists originate. At the university level, biology is again prominent, and again it is largely applied biology. However, there is an important difference as the college or university student progresses through the five-year program. The student specializes quite early and takes advanced work almost from the beginning. In the fifth and final year, all students write a thesis on some project requiring a certain amount of originality. It is here that the superior students develop skills in critical analysis. The very best are privileged to use the experimental laboratories and equipment of the Academies of Science which are associated with the universities. The theses of exceptional worth are published at state expense, and all students must take not only

6. The university museum at Kiev, Ukraine. This museum was totally rebuilt and the entire collection assembled anew after the war.

written examinations in all their subject matter, but they also stand an oral examination on their thesis work. With highly trained college and university teachers, adequate to excellent facilities, and excellent libraries, the theoretical side is evened out with the practical.

From the brief contact we had with educational facilities in the best schools and universities, it is safe to say that biology is considered to be one of the most important subjects in the curriculum. Teachers in the schools come both from teachers' colleges and from universities. In the former case, they receive training in teaching methods, just as in our teachers' colleges. In the latter case, they get teaching experience in a shorter contact with master teachers. Our observations indicate that teachers seem to be firmly confident of the importance of their subject in the development of the Soviet economy. Although we found that they are actually poorly paid by American standards, with salaries from as low as $35 a month to as high as $95, the satisfactions and a feeling of contributing to the "glorious future" seem to compensate for the low pay. Costs of essentials are actually lower, so the difference is not easy to translate into American conditions.

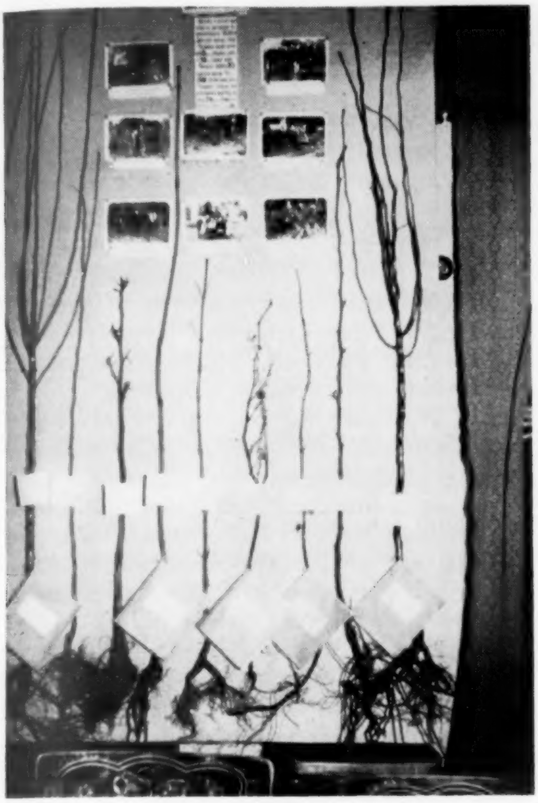
Uniformity of textbooks throughout the vast Soviet Union is well known. The basic textbooks are the same everywhere, even when used in republics of the Soviet Union having languages other than Russian. Teaching materials, such as take-down human torsos, innumerable charts, movies, and specimens are almost exactly the same as they are in this country. But the walls and exhibit rooms are filled with samples of plants raised by the pupils during the summer (in out-of-school time), and flowers and large potted plants are so numerous as to almost crowd in upon the classes and darken the windows.

In a general summary, it might be said that the impression one receives in a visit of only thirty-five days, meeting with officials, teachers and pupils, and asking hundreds of questions, is that education is very serious business in the Soviet Union. It is carefully controlled, with due consideration for the future of a rapidly growing nation. Teachers are not well-paid, but they have rather light loads of a basic eighteen hours per week. In addition to the classroom contact hours, they visit pupils' homes, however, and discuss the problems of individuals with the parents.

Incidentally, there is much less democratic action by parents under their system than under ours. As the teachers and administrators explained it to us, with obvious pride, "Here the parents own the schools, but the teachers run them."

It is hard for us to comprehend the attitude which is clearly present in the Soviet system where the teacher follows the directions of her superiors without departing from the program laid down. Even when there are changes, the teachers appear to accept the changes as beneficial, since they originate "at the top," and teachers don't seem to object to follow-

7. A display to instruct pupils in predator-prey relationships at the Kiev "Nature Lovers' Experiment Station" which serves the city as a practice farm-orchard-animal-breeding station for school pupils. The out-of-school time of children is controlled by the government with numerous clubs of all kinds. The biology clubs use the extensive acreage of this station for year-round studies with the help of a permanent staff, a reprint library, and guidance in experiments. The function is similar to 4-H club work.



8. A student display, with reports, showing various specimens grown by pupils. The photographs induce interest in team-projects. Students work also on farms during the summer, and biology as taught in the schools is exceedingly practical with the aim of developing farm managers. In theory, all pupils learn about economic biology in order to bring their education "closer to life," and the garden and experiment station work implement this theory.

ing specific plans to the letter. They seem to have adopted the philosophy that the unity of all participants in their national effort is vastly more important than the opinions of individuals. It is this philosophy, which is at the core of the competition between the two countries, that poses the greatest challenge to us. We are caught in a dilemma, in a way, because we do not wish to adopt the submissive attitude associated with a political philosophy we find objectionable. Yet the uniformity of approach has undeniable advantages for short range gains. It is unthinkable that we attempt an imitation of their system with its increased attention to biology, yet all of us who have taught the subject are aware of the sense of inadequacy we experience due to lack of time. Perhaps we can increase biology requirements and the variety of our offerings so that more understanding of biology is provided our future citizens, and at the same time, develop our wisely established approach which gives individuals a broader base upon which to observe the biological world—and themselves—with a keener sense of true education.

New NABT Publications

The NABT has published through its Conservation Committee a new *Manual for Outdoor Laboratories* which concerns itself with the development and use of school grounds as outdoor laboratories for teaching science and conservation. Editor is Prof. Richard L. Weaver, University of Michigan. Of the sixteen articles embodied in the handbook, eight have appeared in the ABT during the year 1958-59. This will be a very valuable handbook for all teachers to use in improving the natural resources of the school community for teaching a more effective biology course. Copies may be obtained from the Interstate Press, Danville, Illinois at \$1.25 apiece but there will be a 20 per cent discount on two or more copies. The publisher should be contacted for any wholesale quantities for special prices. A review of the manual will be carried in a future issue of the ABT.

Antarctic Biology Studies

The NSF has just announced that it is continuing the support of the Antarctic Research Program. Activities which concern studies in biological aspects of this are being conducted by Dr. D. E. Wohlschlag, Stanford University, on the ecology of the Ross Sea area; Madison E. Pryor, University of Tennessee, in charge of the U. S. Antarctic Biological Laboratory investigating land invertebrates; Richard L. Penney, University of Wisconsin, penguin research; and Dr. Knut Schmidt-Nielsen, Duke University, with research on metabolism of the penguin.

New nonbreakable animal cages made of durable chemically resistant Fiberglass are one of the items of especial interest to biologists listed in the copy of the new catalog, LabLog No. 1-59, Will Corporation, Box 1050, Rochester 3, New York.

The Use of Bacteriophages in High School Biology

MARION RICHTER
Morris High School, New York
and
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Department of Bacteriology, Indiana University, Bloomington

The bacteriophages, those viruses that are parasitic on bacteria, are objects of great interest to both the research scientist and to the beginning student of biology. Their extremely minute size, their borderline position between the living and the lifeless, and the tremendous speed with which they reproduce within their bacterial hosts all make them objects to engage the imagination and the intellectual interest of most biology students. In addition, the bacteriophages are not pathogenic to man and are relatively easy to grow in the laboratory with limited and inexpensive equipment. They can be used to demonstrate how scientists can handle and count particles too small to be seen with ordinary microscopes. Further, they and bacteria are pratically the only organisms that can be used to demonstrate in the laboratory the way in which natural selection works in eliminating the unfit organisms and in selecting those mutant types that are fittest to survive—all within a twenty-four hour period.

For these reasons the bacteriophages are a rich source of laboratory material for both the biology teacher and for the ambitious student who wants to do an individual project in the biological laboratory. Both the teacher and the student will be well repaid for learning the few techniques necessary to handle them in the laboratory.

The experiments described in this article were suggested and developed by Professor Dean Fraser, Bacteriology Department, Indiana University. They were tried out by the writer and adapted for high school use in the bacteriology laboratory at Indiana University during the summer of 1959.

The experiments are designed to require a minimum of equipment and to allow considerable flexibility and margin for errors. The actual materials and equipment needed are the following: six-ounce prescription bottles with screw caps (such as those used by druggists), about twenty-four medicine droppers with bulbs (*or* home-made pipettes, made from glass tubing, *or* a few graduated pipettes in sizes 0.1 ml., 1.0 ml., and 5.0 ml.), one transfer needle and one transfer loop each made of either Nichrome or platinum wire set in a metallic handle, sterile petri dishes each containing about twenty mls. of sterilized nutrient agar, sterilized test tubes with either cotton plugs or with metal caps, an autoclave or pressure cooker for sterilizing agar and broth and glassware, a refrigerator in which to store the cultures of virus and of bacteria, or some other means of keeping the cultures refrigerated. An incubator is desirable since it greatly shortens the time required for growing the cultures and gives more consistent results because its temperature is constant. However, if no incubator is available, the cultures, both viral and bacterial, can be grown at room temperatures ranging from 70°-80° F. All of these experiments were tried at room temperature and were found to give satisfactory results. A jar or tray of disinfectant into which the used droppers or pipettes can be dropped is also needed. Nutrient agar and nutrient broth can be prepared from formulae and can be sterilized, but this is quite time consuming. Bottles of prepared and sterilized agar and broth can be purchased at very nominal cost (e.g., Difco) and save a great deal of time and labor. If sterile plastic petri dishes are used the time and work of cleaning them for reuse is eliminated, since they are simply flooded with disinfectant and discarded. A glass spreader made by bending glass rodding (e.g., 3 mm. diameter) is used for spreading plates.

Finally, a stock culture of the bacteria. *Escherichia coli*, Strain B, and also a culture of T_1 bacteriophage at a concentration of about 10^{11} particles per ml. are needed.[1] When the

[1]Appropriate stocks of the bacteria and of the phage can be obtained from Prof. Dean Fraser, Bacteriology Department, Indiana University, Bloomington, Indiana. A mimeographed sheet, also available

bacterial and viral cultures are obtained they should be kept in the refrigerator until they are to be used.

General Explanations

Before proceeding with the description of the experiments a few general comments concerning the materials may be in order. Those submicroscopic entities that multiply parasitically in living bacterial cells are called bacteriophages or bacterial viruses, or simply, phages. The terms are used interchangeably. Since the above bacteria and phages have been used for at least twenty years by students in many laboratories without a single report of infection, they can be considered non-pathogenic to man. Nevertheless care in handling them should be observed.

The phage cultures will be sent out in a highly concentrated form. For most of the experiments they must be diluted before use. For this purpose we use what are described as serial dilutions, that is a drop of the phage stock is transferred into a bottle of sterile nutrient broth and thoroughly mixed. From this bottle one drop is transferred into a second bottle of sterile broth and mixed. This is the bottle from which we take the phage used in the experiment concerned. In the assay experiment a third dilution bottle is required.

While contamination of the tubes and bottles of cultures is not usually much of a problem in these experiments, contamination of the stock cultures of both *E. coli B*, and of the T1 phage must be avoided. If these become contaminated it then becomes impossible to know what you are working with in any given experiment. To avoid this contamination it is necessary to use what are called "sterile techniques." In this the transfer loop or pipette used for the transfer of bacteria or phage from their respective culture tubes must be flamed just before using, the mouth of the culture tube is flamed, the loop or pipette is inserted into the stock culture and the sample is removed, the stock culture tube is flamed again and the plug or cap replaced on it. It is only when transferring from these two tubes that this technique is used. The transfer loop should be flamed a second time as soon as the transfer is completed. The pipettes or droppers are put into disinfectant solution as soon as the transfer is made.

There follows descriptions of several experiments that can be used to illustrate important biological principles. At the same time the students gain some acquaintance with an important and unusual biological entity. None of the experiments is difficult to do nor do they take long. Some can be carried on by students as their special projects.

Experiment 1—Assay of Bacteriophage by the Plaque Technique

This experiment demonstrates how scientists estimate the number of virus particles that are present in each cubic centimeter (1.0 mls.) of liquid medium. It also shows the appearance of the typical plaques by which we recognize the presence of the bacteriophage.

1. The day before the experiment is to be done, transfer one drop or one wire loopful of the stock culture of *E. coli B* to a bottle of sterile broth, using sterile techniques. Let the bottle stand either in the incubator at 37° C. (98° F.), or at room temperature of 70°-80° F., until the next day. This allows the bacteria to become adapted to the broth in which they will grow.
2. Dilute the T_1 stock culture by three serial dilutions. Using sterile technique transfer 1 drop from the stock culture of T_1 to a bottle containing about 80 mls. of sterile broth. Use either a transfer loop, flaming before and after each transfer, or take a clean pipette for each transfer. Label the infected bottle "1." In the same way transfer from bottle 1 to bottle 2, from 2 to 3. Label each bottle as you make the transfer; mix thoroughly.
3. From bottle 1 take a drop and transfer it to a sterile agar plate. Add a drop of the broth culture of *E. coli B* to the plate, mix, and spread the drops over the agar surface. Spread by rotating the petri dish with the left hand while you draw the spreader across with the right hand. The spreader is a piece of glass rod bent almost at right angles; this is dipped in 95% alcohol and flamed to remove the alcohol before each spreading, and then placed in alcohol until ready to use on the next plate when it is flamed again.

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from Dr. Fraser, lists sources of other materials and gives detailed directions for making and sterilizing the nutrient broth, sterilizing the medicine droppers, making a simple transfer needle, and making the plate spreader.

When finished, the spreader is dipped in alcohol and flamed again. Spread plates from bottles 2 and 3 in the same way. Label each. Spread a fourth plate with a drop of the bacterial culture and omit the phage. This is your bacterial control plate, your evidence that the culture of bacteria was not contaminated. Label this "control."

4. Let all plates stand overnight at room temperature or incubate.
5. Examine the plates the next day. They should be covered with a film of bacteria. Scattered over the film should be round clear spaces or plaques. Each plaque contains very large numbers of phage particles. All these are the descendants of a single phage particle which infected a single *E. coli B* cell, reproduced inside of it, and finally caused the bacterium to burst open, releasing more phage particles which then destroyed other bacteria adjacent to them. By counting the number of plaques formed on a plate, multiplying by the dilution, and then multiplying by 10 for the amount used in plating, the number of infectious phage particles per ml. that were present in the original stock is determined.

Experiment 2—Demonstration of the Presence of Phage in a Plaque

To convince oneself that these empty-looking lysed spots are filled with phage, transfer into a bottle containing 80 mls. of sterile broth material from a single plaque. First flame a wire transfer needle, then carefully stab an isolated plaque on one of the plates and rinse the needle in the bottle of sterile broth. Place a drop or loopful of an overnight broth culture of *E. coli B* on a sterile agar plate. Add a drop or loopful of the broth-phage suspension just made. Mix and spread the drops with the glass spreader. Let the plate stand overnight. The appearance of plaques on this plate, indicating the presence of phage, shows that the phage was transferred with the loop from the other plate.

Experiment 3—Killing (Lysing) of Susceptible Bacteria with the Bacteriophage T1

1. From the stock culture of *E. coli B*, using sterile techniques, take one drop of the culture with a wire transfer loop, and transfer to a bottle containing about 80 cc. of sterile nutrient broth. Let the bottle stand overnight either at room temperature or in the incubator to allow the bacteria to become adapted to the broth.
2. The next day transfer about one ml., or a medicine dropperful, to each of two bottles of sterile broth. Let the bottles stand until they show a *barely* visible turbidity, or clouding, of the broth. This requires about two-three hours in the incubator, or about four-five hours at room temperature.
3. When the turbidity is barely visible add one drop of the undiluted stock phage culture of T_1 to one of the bottles. The second bottle (without T_1) is your control.
4. Allow both bottles to stand until lysis occurs in the first bottle. (40-60 minutes in the incubator, or 60-75 minutes at room temperature). Lysis is shown by the clearing of the culture containing T_1, while the control bottle becomes more turbid than it was.

The clearing occurs because the concentrated T_1 provides ten virus particles for each bacterial cell, assuring that all the bacteria will be infected. In the interval between infection and lysis (latent period) each phage particle inside a bacterial cell will cause the production of approximately 100 more phage particles. This process is terminated by the bursting of the *E. coli* cell, with the release of the phage particles. When the *E. coli* cells burst the culture clears. It is only by the killing of the bacteria that the presence of the phage can be recognized. Save both bottles for use in Experiment 4 the next day.

This experiment is easy to carry out, and it is quite effective, but the timing may cause difficulty if it is to be shown to classes early in the day. Several modifications were tried, of which the following was the most successful. Inoculate the two bottles of broth as late as possible the day before it is to be shown. Use the smallest amount of *E. coli* broth culture as possible; i.e., one wire transfer loopful in each bottle. Stand the bottles in a plastic pail or similar container and pack the pail with ice. Use a pail small enough so that when the ice melts the bottles will still remain upright. Let them stand at room temperature over night. Sometime during the night the ice will melt and the cultures will

start to grow. The growth will be slow. By morning it should reach the barely visible turbidity desirable. In the experiment tried out, this point was reached a little before ten a.m. At this time the phage was added to one bottle. Both bottles were kept at room temperature, in this case about 76° F. Complete lysis occurred between 11:30-11:45 a.m. Had the bottles been incubated, lysis would probably have occurred at approximately 10:40 a.m. By adjusting the bacterial inoculum and the amount of ice it would be possible to have the culture ready earlier or later the next day. To fit this to a particular school schedule the teacher will have to time the infection of the bottles carefully, perhaps starting in the ice several bottles with different inocula.

Experiment 4—Growth of Resistant (Mutant) Bacteria Selected by the Action of Bacteriophage. (Natural Selection)

If the bottle in which the lysing of the *E. coli* cells occurred is allowed to stand overnight, the broth will be very turbid by the following morning. This turbidity is produced by *E. coli* bacteria which were not visible in the broth the night before. These are cells that are resistant to the T_1 phage. The turbidity of this bottle should be compared with the turbidity of the control bottle. These resistant bacteria are mutants. They can be grown both in broth and on plates.

1. Dilute the T_1 stock culture by transferring one drop to a bottle containing 80 mls. sterile broth, and then one drop from this bottle to a second bottle of broth. Mix each bottle thoroughly, and label them 1 and 2.
2. Take one drop of the culture of resistant *E. coli B* cells saved from the experiment the day before and place on a sterile agar plate. Add one drop of the phage-broth suspension in bottle 2. Spread the drops over the plate with the glass spreading rod and label.
3. Add a drop of the culture of susceptible *E. coli* from the experiment of the previous day to a second sterile agar plate. Add a drop of the T_1 broth suspension from the second dilution bottle prepared in step 1 and spread over the agar. Label the plate.
4. Let both plates stand overnight.
5. If it is desired to have a culture of resistant *E. coli* cells, one drop of the culture from the day before in a bottle of sterile broth will provide this.
6. After standing overnight the plate with resistant *E. coli* cells on it should have no plaques on it, just a film of bacteria. The plate with the susceptible *E. coli* cells should have the plaques as usual.

The presence of these resistant cells in the bottle in which lysis occurred the day before is due to the fact that in the original culture of *E. coli B* there were extremely rare cells that were resistant to T_1. However until they were exposed to T_1 we had no means of recognizing their presence. When the susceptible cells in the culture were lysed by T_1, these rare, resistant cells escaped lysis, and proceeded to multiply rapidly, handing on to their progeny this new characteristic of resistance to T_1.

These resistant mutant cells that hand on their mutated character to their offspring were selected by the action of the T_1 bacteriophage which eliminated the susceptible *E. coli* (the "unfit") and let the resistant forms (the "fittest") survive. This illustrates natural selection and survival of the fittest in the usual sense of these terms. Incidentally, it was the T_1 bacteriophage with which Delbrück and Luria first demonstrated these principles in the laboratory. This is one of the few cases in which these principles can be demonstrated easily in the classroom.

The experiments which follow are somewhat less fundamental than are the first four experiments. They are included because they illustrate the way in which the phage is handled in testing the effects of factors such as light, heat, and chemicals on microscopic organisms. These might very well suggest projects for individual students to work on.

Experiment 5—Killing Virus (Bacteriophage) by the Action of Ultraviolet Light

If an ultraviolet lamp or a sunlamp is available it is possible to show the killing effect of ultraviolet light on the bacteriophage. The writer used a Hanovia Letheray Germicidal Unit with a 15 watt bulb, at a distance of 50 cm. above the surface on which the samples were exposed.

1. The day before the experiment is to be done add a drop of the stock culture of *E. coli B* to a bottle of sterile broth (about 80 mls.), using sterile precautions, and let stand overnight.
2. Dilute the T_1 stock to the desired con-

centration. Using sterile technique, transfer one drop of the stock culture of T_1 to a bottle containing about 80 mls. of sterile nutrient broth. Then, using another sterile pipette, transfer one drop from this bottle to a second bottle of sterile broth.

3. Into a sterile test tube put 2.8 ml. of sterile broth. Add 0.2 mls. of the infected broth from the second bottle. Pour this sample into a sterile petri dish and cover. If graduated pipettes are not available this dilution can be made approximately.
4. On to each of several sterile agar plates place one drop of *E. coli B* from the culture grown in step 1. Any number of plates could be used. In our experiment five plates were infected and spread. Label each plate with the time for which its sample of phage will be irradiated. Any time interval could be used. In our experiment the times of exposure were 0 (control), 15 seconds, 30, 45, and 60 seconds.
5. Take the plates and pipettes or transfer loop to the place where the lamp will be used. Take a drop from the sample in the petri dish and place on the plate labeled "control," since this is an unexposed sample. Spread the plate with the glass spreader. Remove the cover from the plate with the sample and expose the sample to ultraviolet light for 15 seconds, keeping the plate in motion with a gentle side-to-side movement during the exposure. Cover the plate, remove from under the light, take a drop from the irradiated phage suspension, and spread on plate labeled 15 seconds. Expose the sample for an additional 15 seconds, remove from the light, put a drop on the "30 seconds" plate, and spread in the usual way. Repeat the process for the other exposure times.
6. Let the plates stand overnight. The next day examine and count the number of plaques on the plates. This should show the effects of increased exposure to a specific strength of ultraviolet, and the point at which this exposure will result in total inactivation of the T_1 bacteriophage.

Experiment 6—Killing Virus by the Use of Detergents or Other Chemicals

The effect of detergents or other chemicals on the growth of bacteriophage can be tested rather easily.

1. Inoculate a bottle of about 80 cc. of sterile broth with one drop of the stock culture of *E. coli B*. Let stand overnight.
2. Make a saturated solution or any desired strength of detergent or other chemical.
3. Dilute the stock phage culture, using two serial dilutions each in 80 mls. of sterile broth. Put 1 ml. sterile broth into a test tube. Add a drop of the T_1 phage from the second dilution bottle just made.
4. Transfer a drop of the *E. coli* broth to a sterile agar plate. Add a drop from tube just prepared and spread the plate with the glass spreader. Label this plate "control." Label each of four other sterile agar plates with the exposure times it is desired to test.
5. Add 0.1 ml. of the saturated solution of detergent to the tube with the broth-T_1 suspension and start timing. At one minute take a drop of the suspension, place on a sterile agar plate, add a drop of the *E. coli* broth culture, spread the plates. Repeat after 5, 10, and 15 minutes. Be sure that the samples are placed in the correctly labeled plates. Let the plates stand overnight.
6. If the effect of the detergent or chemical on the bacteria is not known, the detergent must be tried against the *E. coli* just as it was for the phage, except that these plates are not spread with phage. All we want is to see the effect on the bacteria alone. For this experiment we must have a chemical that will not destroy the *E. coli*, otherwise we will not be able to distinguish between the action on *E. coli* and that on the phage.

Experiment 7—Killing Bacteriophage by the Use of Heat

The effect of heat on the T_1 bacteriophage can be shown in almost the same way as we showed the effect of chemicals

1. Grow an overnight broth culture of *E. coli B* as we did for the other experiments.
2. Dilute the T_1 stock culture with two serial dilutions in 80 mls. of sterile broth, as we did previously.
3. Take a 2 mls. (2 cc.) sample of the second dilution of T_1 in a sterile test tube. Stand the test tube in a beaker contain-

ing water previously heated to 65° C. using a thermometer in the beaker. At one minute remove the tube and stand in a beaker of ice. Take a drop from the tube place on agar plate, add a drop of the *E. coli* culture, spread the plate, and label with the time and temperature. If the water can be kept at the same temperature for some time, put the sample tube back in the water for four additional minutes and plate in the same way. If the temperature can still be maintained, take another sample at the end of ten minutes, and plate again. If the temperature cannot be held constant, then try a sample heated for one minute to 60°, another heated for one minute at 70°, another at 80°, 90°, and 100°. Be sure the plates are correctly labeled.

4. Examine the plates the next day and count the plaques at the various exposures.

Math and Leaves

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Science teachers are all aware of the use of mathematics in science; however, students in elementary biology often pass through the course without having to use any greater mathematical skill than the ability to count. It is little wonder that students with poor aptitudes in mathematics are often advised by administrators to take biology in order to fulfill the science requirement. While it is true that elementary biology requires less mathematics than physics or chemistry at a similar level, it is indeed unfortunate that any student should satisfy his secondary school science requirement without recognizing the value of, and the need for, mathematics in science.

There are a number of areas in biology where the relationship between mathematics and science can be shown. Genetics is an excellent area in which to introduce probability. The study of evolution may include a discussion of geometric and arithmetic progression as well as the use of scientific notation (age of the earth = 4×10^9 years).

One laboratory exercise with which I have had considerable success serves as an excellent review of the metric system of linear measure as well as making the students cognizant of the use of mathematics in science. During our study of botany, the students prepare a slide of a section of the lower epidermis of a leaf (geranium is good). After they have examined the structure of a stomate in detail, they are asked to determine the total number of stomates on the lower surface of the leaf from which they prepared their slide. Some students can solve this problem without help, but most of them must be given a few hints. They must first determine the area which they view with the low power lens. This can be approximately determined by focusing on a metric ruler and finding the diameter of the field. By means of the formula pi r^2 the area of the field can be determined. The student then makes several counts of the stomates from random parts of the prepared slide and finds the average number of stomates per previously determined area. In order to find the total number in the lower epidermis, he must find the area of the leaf from which he removed a part of the lower epidermis. This can be done by tracing the outline of the leaf on a piece of paper and then, by dividing the outline into familiar figures, determining the enclosed area. Some geranium leaves are almost a circle with a small triangle removed.

The student, knowing the total area of the leaf and the number of stomates per smaller area, should be able to determine the number of stomates on the lower epidermis.

A sample determination is given below:

Diameter of microscopic field = 1.5 mm
Area of microscopic
  field = $3.14 \times (0.75)^2 = 1.8$ mm^2
Average number of stomates per
  field = 150
Area of leaf = 1800 mm^2
Total number of stomates = $150 \times 1000 = 150{,}000$

I think the above exercise is excellent for a number of reasons. First, it makes the student aware of the use of mathematics in science. Second, it provides a bit of the flavor of quantitative measurement. Third, it gives further insight into the size of cells, while providing a view of an important leaf structure. Fourth, and perhaps most important, it requires the student to think.

Cigarette Smoking and Disease

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By far the most important achievement of mankind during the last century has been the conquest of disease. Death rates from almost all of the infectious diseases have dropped to a small fraction of what they were a few decades ago. As a result, life expectancy in the United States rose from 40 years for males and 43 years for females in the 1850's to 67 years for males and 73 years for females in 1956. Crude death rates from some of the chronic and old-age diseases have increased simply because there are now more old people in the population. However only a few diseases have shown an increase in age-standardized death rates.

Lung cancer is a great exception in this otherwise favorable picture. Age-standardized death rates from this disease among men have increased more than 7 fold during the last 25 years in the United States. (See figure 1.) The same thing has occurred in many other countries. Lung cancer death rates have also risen among women but not nearly so rapidly as among men. Some of this apparent increase probably resulted from improved diagnosis and reporting of causes of death. However, the evidence indicates that a very great increase actually occurred.

Unfortunately, lung cancer is a highly fatal disease, the cure rate being only about 5% at the present time. Therefore a tremendous amount of research has been undertaken to determine the causes of lung cancer in the hopes that this will lead to some method of prevention.

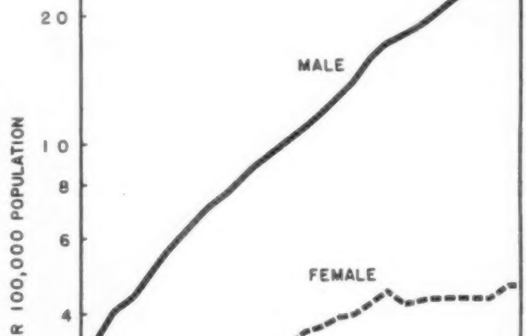
It is possible that because of hereditary differences some people are more susceptible than others to lung cancer. However, it is most unlikely that changes in heredity could account for the increase in the disease. I say this because it would take many generations for a hereditary factor to become widely spread throughout the populations of the many different countries in which lung cancer death rates have increased greatly during the last few decades.

These considerations lead to the conclusion that the increase in lung cancer must have resulted from the increased exposure of human beings to some environmental factor or factors which give rise to the disease.

Lung cancer is a malignant neoplasm which arises in the epithelium which lines the bronchial tubes of the lungs. This is a beautifully simple tissue. On cross section it appears microscopically as one or two rows of small, round, basal cells lying on the basement membrane and one row of ciliated columnar cells interspersed with goblet cells. Under normal conditions, the surface is bathed in mucus secreted by the goblet cells. The cilia, which are in constant motion, produce a flow of the mucus up through the bronchial tubes and the trachea. When small particles of foreign material are inhaled, they are trapped by the mucus and together with the mucus are eliminated from the lungs. This protective mechanism breaks down if the cilia are destroyed or inhibited.

It is a well established fact that lung cancer can be produced by prolonged and heavy exposure to a number of quite different sub-

CANCER OF THE LUNG DEATH RATES, BY SEX
United States, 1930-1956



stances which come into direct contact with bronchial epithelium. These include occupational exposure to dusts containing radioactive substances, chromates, or nickel. However, lung cancer occurs among people in all walks of life, few of whom are exposed to the particular substances mentioned above. This suggests that lung cancer in the general population may be produced by inhalants to which people of all occupations are exposed.

Since lung cancer has increased greatly, one would be most suspicious of widespread inhalants which have increased greatly during the same period of time. Several different factors in our environment meet this specification, namely: cigarette smoke, dust from asphalt roads, and general air pollution from automobile exhausts, combustion products of fuel oil, and dust and fumes from industrial plants and incinerators. These same substances contain small quantities of chemicals which are capable of producing cancer when smeared on the skin of experimental animals. Therefore, all of them have been studied intensively.

Present evidence suggests that general air pollution may account for some cases of lung cancer. In certain cities, such as Liverpool, (1) where air pollution has been excessive for many years, this may be an important factor. Elsewhere, it appears to be of relatively minor importance at the present time. However, it may become serious in the future if effective control measures are not adopted.

Now let us consider the evidence concerning cigarette smoking.

Tobacco smoke is a highly complex mixture of alkaloids, aldehydes, ketones, acids, alcohols, phenols, hydrocarbons, various other organic compounds, and many different inorganic compounds. (2) A person who inhales the smoke from two packs of ordinary cigarettes absorbs an amount of nicotine which would kill him in short order if administered in a single dose. In addition, tobacco smoke contains an appreciable quantity of carbon monoxide, small amounts of other potent poisons (including arsenic, hydrogen sulfide, and hydrogen cyanide) and numerous polycyclic hydrocarbons. It would indeed be surprising if such a mixture did not produce a multiplicity of biologic effects. Some of the effects which have been demonstrated experimentally are the following:

Tobacco smoke inhibits action of the cilia in the bronchial tubes. (3, 4) In other words, it interferes with the protective mechanism whereby foreign material is ordinarily removed from the surface of bronchial epithelium. Cancer can be produced on the skin of mice and rabbits by the application of material condensed from cigarette smoke. The most active component in respect to mouse skin cancer is one small fraction of neutral tar. (5) Due to nicotine, smoking has a stimulating effect on the central nervous system and autonomic ganglia, induces secretion of the antidiuretic hormone from the posterior lobe of the pituitary gland, increases blood sugar, causes constriction of peripheral blood vessels, temporarily increases blood pressure and heart rate, and has a marked effect on the electrocardiograms, and ballistocardiograms of some people. (2) Probably due to carbon monoxide, cigarette smoking produces an increase in red blood cell counts and in packed cell volume. (6) Well controlled experiments have shown that smoking has a marked deleterious effect on patients with peptic ulcers.

When a carcinogenic chemical is applied to living tissue a number of changes (such as hyperplasia, metaplasia, atypical cells, and carcinoma-in-situ) usually occur long before the appearance of cancer. Auerbach (8) and his associates have made microscopic studies of thousands of specimens of bronchial epithelium removed from human lungs at autopsy. Among people who died of lung cancer, many tissue changes of the types mentioned above were found in parts of the lungs not involved by the tumor. Almost as many such changes were found in the lungs of heavy cigarette smokers who died of diseases other than lung cancer; fewer such changes were found in light cigarette smokers; and very few were found in nonsmokers. These same changes have been produced experimentally in the lungs of mice exposed to cigarette smoke.(9)

In light of these indications, one may ask whether death rates from lung cancer and other diseases are any higher among smokers than among nonsmokers.

The first attempts to answer this question were carried out in an inverse fashion. That is, studies were made of the smoking habits of people with lung cancer and certain other diseases compared with the smoking habits of people who did not have these diseases. Twenty-two such studies of smoking in re-

lation to lung cancer have now been carried out independently in eight different countries. In every one of these, a far larger proportion of smokers (particularly heavy cigarette smokers) was found amoung lung cancer patients than among people without this disease. This has been shown for both men and women. Similar studies have shown an association between smoking and cancer of the buccal cavity, cancer of the larynx, cancer of the bladder, coronary artery disease (the most common form of heart disease), and Buerger's disease (a circulatory disease of the extremities).

Primarily because of our interest in lung cancer, we decided to check these findings by a more direct method.(10) After designing and pretesting a smoking questionnaire, we recruited and trained some 22,000 American Cancer Society volunteers as researchers for our study. Each volunteer was asked to have about 10 men between the ages of 50 and 69 fill out a questinnaire. They were told not to enroll men who were seriously ill or men who were known to have lung cancer. Once a year thereafter they reported on each man as "dead" or "alive" and a copy of the death certificate was obtained on each death reported. Further medical information was obtained whenever cancer was mentioned on a death certificate. The study area included 394 counties in nine states.

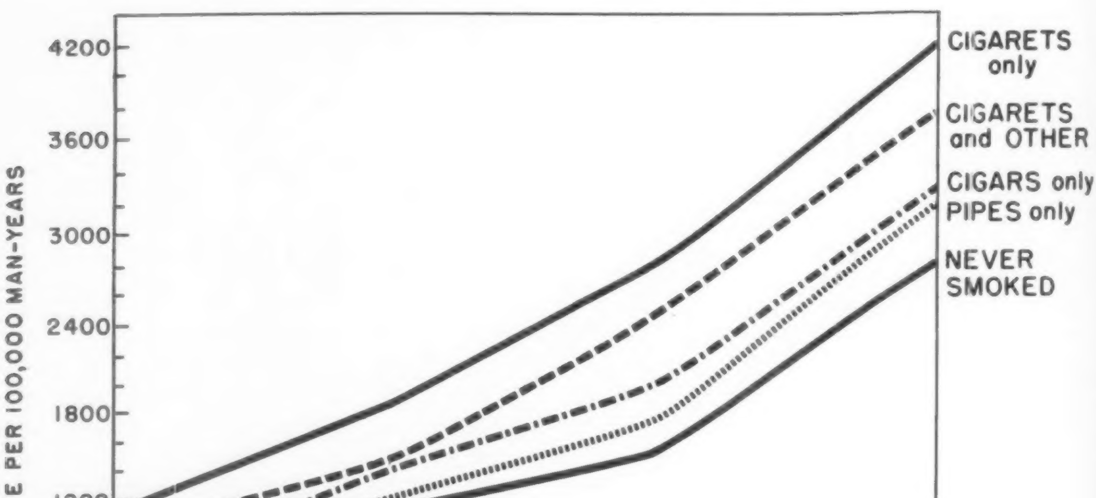
Between January and June of 1952, satisfactory smoking questionnaires were obtained from 189,854 men; 187,783 of them were traced by the volunteers through October 1955 and 11,870 deaths were reported.

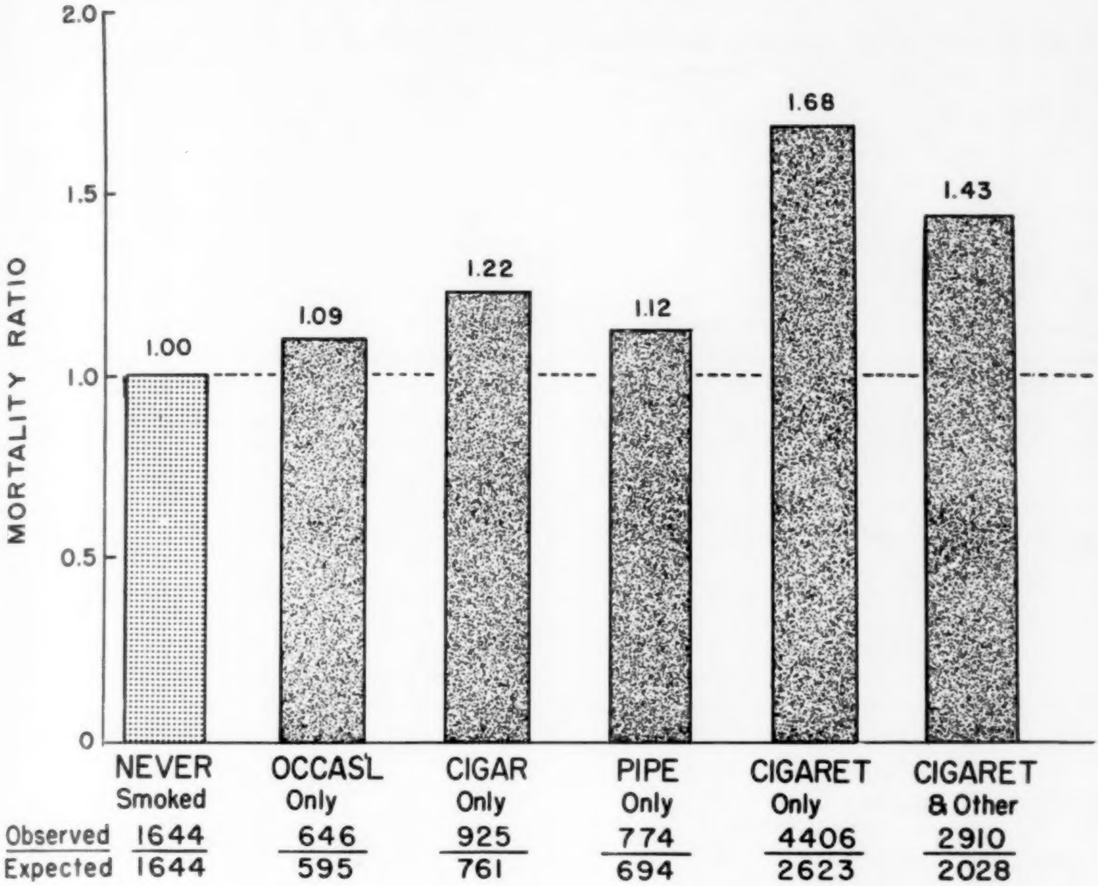
Total Death Rates

Figure 2 shows the age specific death rates per 100,000 man-years by type of smoking. Note that men with a history of regular cigarette-smoking-only had the highest death rates. Men who had never smoked had the lowest death rates. The others fell in between.

In order to summarize these findings, we computed the number of deaths which would have occurred in each smoking category if their age specific death rates had been exactly the same as for men who never smoked. (See Figure 3.) This will be referred to as the "expected" number of deaths. The expected number of deaths divided by the observed number of deaths is called the mortality ratio. By this definition, the mortality ratio for men who never smoked is 1.00.

Among men with a history of cigarette-





smoking-only, 4,406 deaths were observed during the course of the study compared with just 2,623 expected. Thus the mortality ratio (4,406 ÷ 2,623) was 1.68. In other words, the death rate of these cigarette smokers was 68 per cent higher than the death rate of men who never smoked, age being taken into consideration. Men who smoked cigarettes but also smoked cigars or pipes had a mortality ratio of 1.43. For cigar smokers the mortality ratio was 1.22 and for pipe smokers the mortality ratio was 1.12.

It is not certain why the death rate of cigar and pipe smokers was lower than the death rate of cigarette smokers. However, it is reasonable to suppose that tobacco smoke is more likely to have an effect upon a person who inhales the smoke than upon a person who does not inhale the smoke. The results of a recent study (11) indicate that the great majority of cigarette smokers inhale while cigar and pipe smokers seldom inhale. Men who smoke both cigars and cigarettes inhale less than men who smoke only cigarettes.

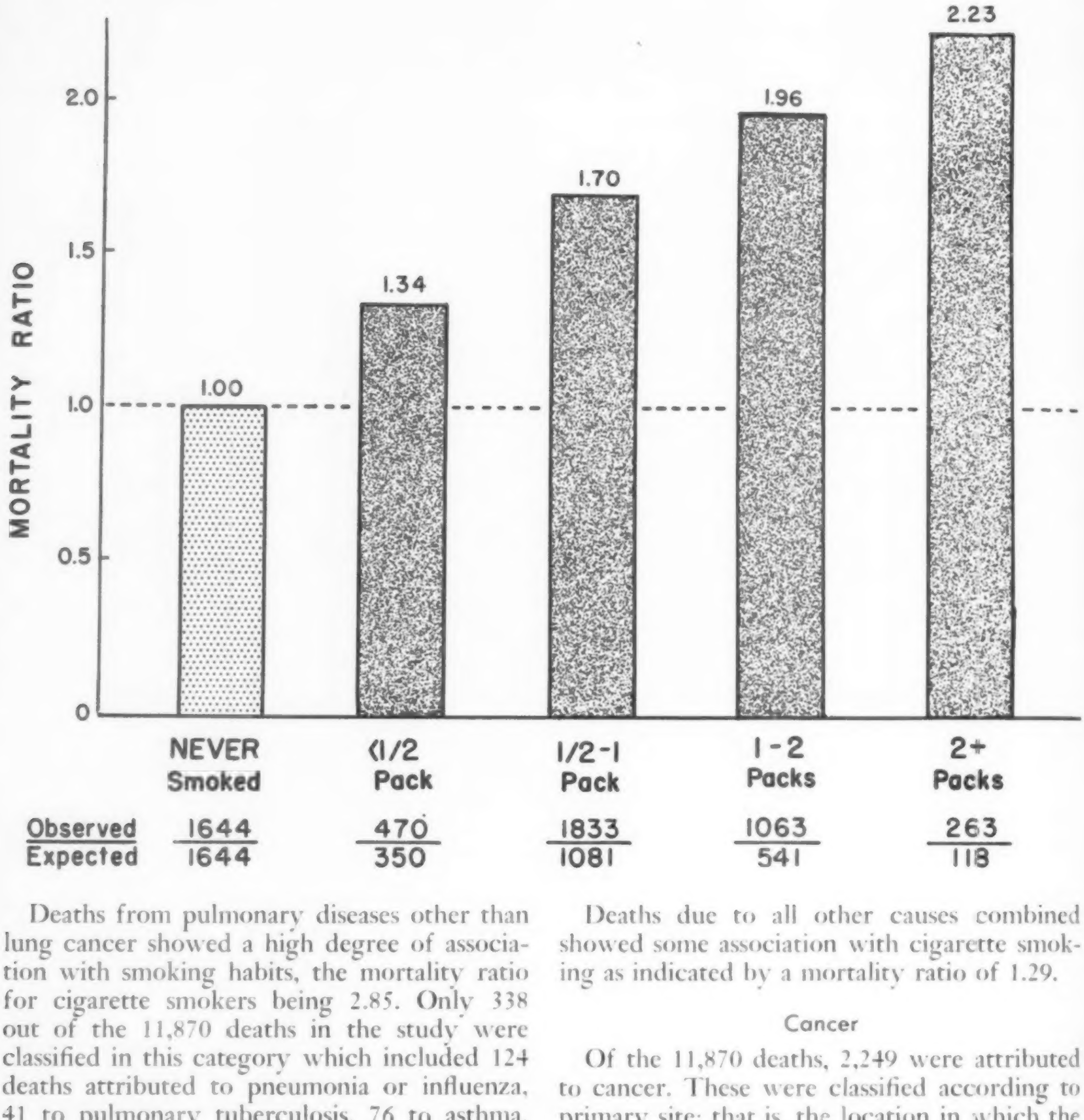
Men with a history of regular-cigarette-smoking-only were classified by their current amount of cigarette smoking in 1952. As shown in Figure 4, the death rate increased steadily with the amount of cigarette smoking.

For those who smoked less than one half a pack of cigarettes a day, the death rate was just 34 per cent higher than for men who never smoked. For those who smoke two packs or more of cigarettes a day, the death rate was 123 per cent higher than for men who never smoked.

Death Rates by Broad Categories of Causes

Having found a high degree of association between cigarette smoking and the total death rate, we next sought to determine what diseases were involved. For this purpose, we first divided the deaths into just five broad categories as shown on Figure 5.

Deaths from accidents, violence, and suicide appeared to be unrelated to smoking habits.



Deaths from pulmonary diseases other than lung cancer showed a high degree of association with smoking habits, the mortality ratio for cigarette smokers being 2.85. Only 338 out of the 11,870 deaths in the study were classified in this category which included 124 deaths attributed to pneumonia or influenza, 41 to pulmonary tuberculosis, 76 to asthma, and 97 to other lung diseases such as bronchitis and pneumoconiosis. While all of these seemed to be associated with cigarette smoking, pneumonia and influenza showed the highest degree of association with a mortality ratio of 3.90.

1,460 cigarette smokers died of cancer compared with an expected of only 741, had their age specific death rates been the same as for men who never smoked. The mortality ratio was 1.97.

The deaths of 4,593 cigarette smokers were attributed to diseases of the heart and circulatory system as compared with 2,924 expected, the mortality ratio being 1.57.

Deaths due to all other causes combined showed some association with cigarette smoking as indicated by a mortality ratio of 1.29.

Cancer

Of the 11,870 deaths, 2,249 were attributed to cancer. These were classified according to primary site; that is, the location in which the disease presumably originated. Altogether, 448 lung cancers were reported. However, in some instances, the diagnosis was somewhat uncertain. Considering only those cases in which the diagnosis was based upon reliable medical evidence (and excluding adenocarcinoma which seems to be different from other types of lung cancer) there were 309 deaths well established as being due to bronchogenic carcinoma (the most common form of lung cancer).

Figure 6 is based upon the well established cases of bronchogenic carcinoma described above. It shows age-standardized death rates per 100,000 man-years for men who never

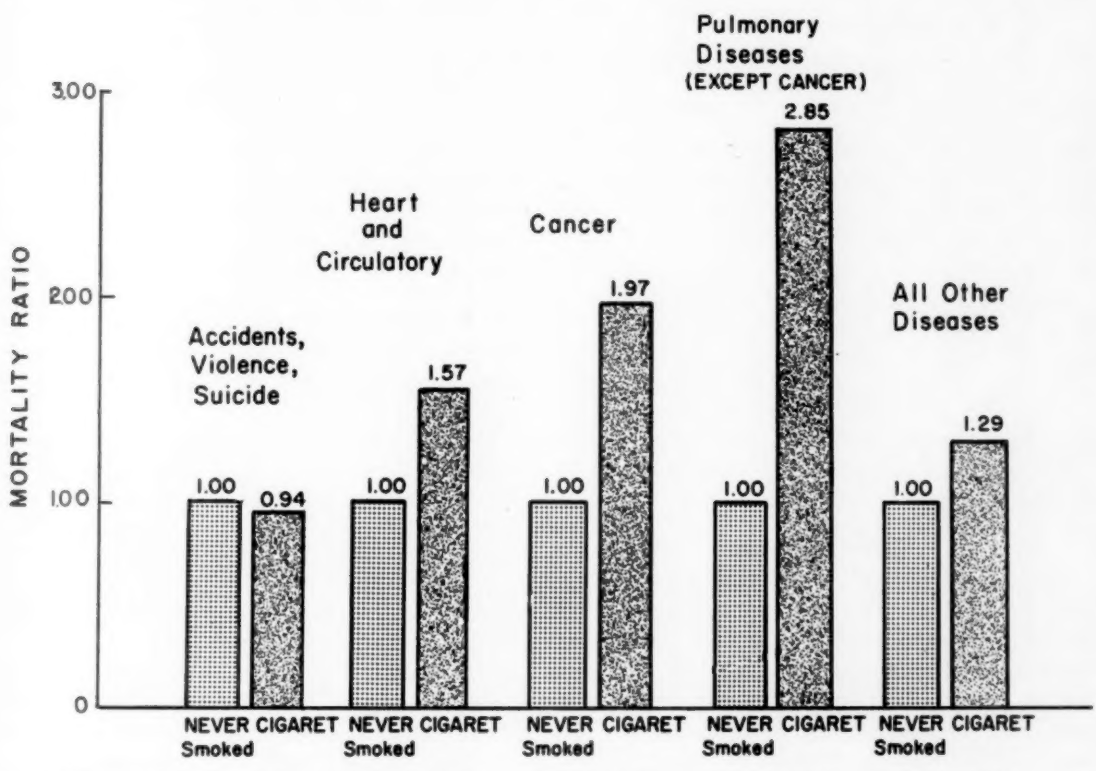
smoked compared with men who smoked various numbers of cigarettes per day (and smoked nothing but cigarettes). Note the very low death rate of men who never smoked compared with the relatively high death rate of light cigarette smokers and the much higher death rate of men who smoked two packs or more of cigarettes per day. The ratio between the two extremes (nonsmokers compared with very heavy cigarette smokers) is on the order of magnitude of 60 to 1.

Of interest is the fact that the lung cancer death rate of ex-cigarette smokers was lower than the lung cancer death rate of men who were currently smoking cigarettes at the time they were enrolled in the study. A more detailed analysis of the data showed that among men who had once smoked the same number of cigarettes per day, the lung cancer death rate was much lower for those who had stopped smoking for at least a year than for those who continued to smoke.

The lung cancer death rate of cigar and pipe smokers was higher than the rate for nonsmokers but very much lower than the rate of cigarette smokers.

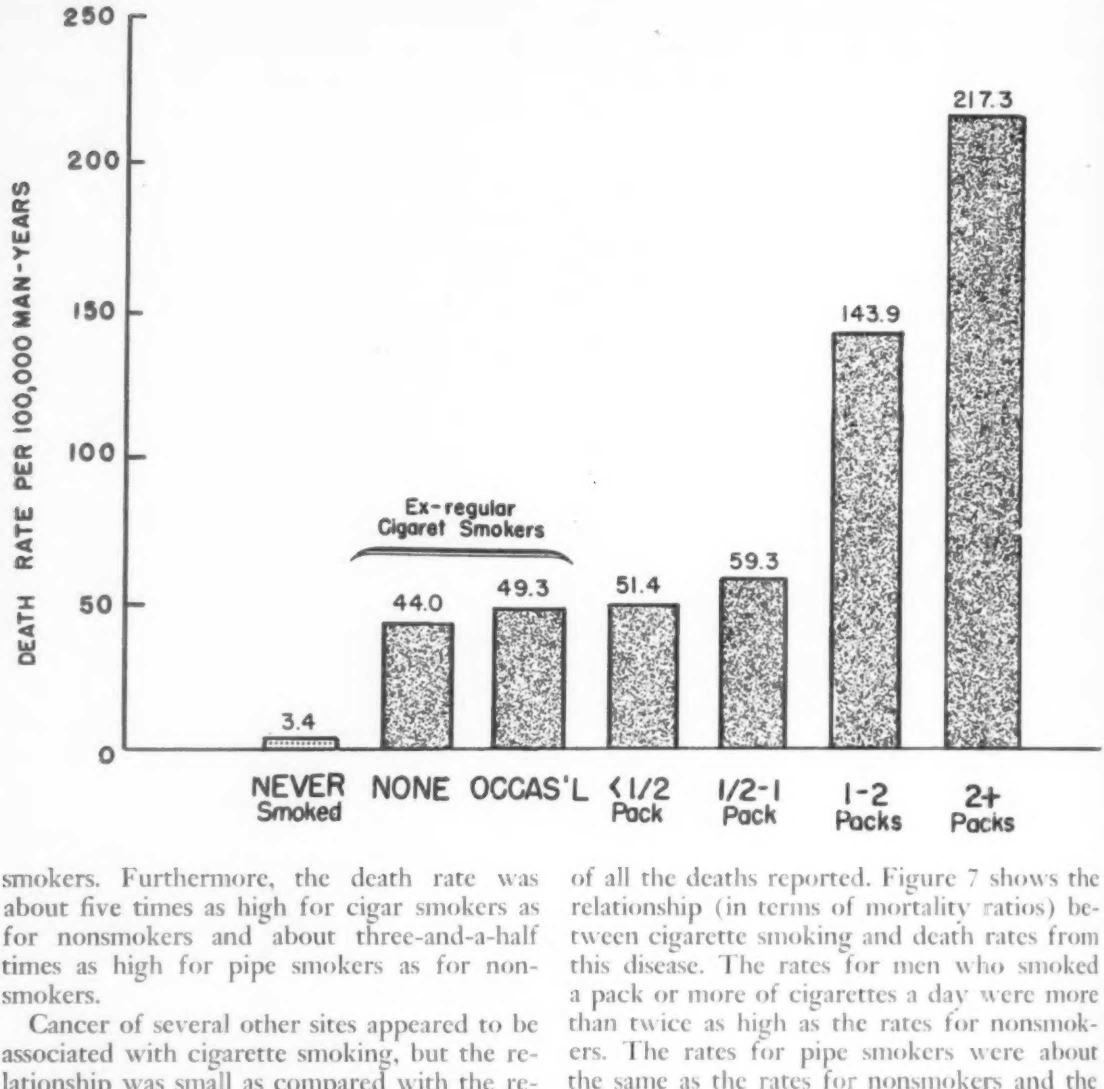
An analysis was made of lung cancer death rates of men living in large cities as compared with men living in rural areas. Holding amount of cigarette smoking constant, the rates were somewhat higher in urban areas than in rural areas, a finding which supports the hypothesis that air pollution may be a factor in the causation of lung cancer. However, the relationship between cigarette smoking and lung cancer was essentially the same in all areas. The urban-rural difference in death rates was very small as compared with the difference between cigarette smokers and nonsmokers.

A total of 127 deaths were attributed to cancer originating in the esophagus, larynx, pharynx, mouth, tongue, or lip (all of which are sites which may be directly exposed to tobacco smoke or material condensed from tobacco smoke). The death rate from cancer of these sites was about seven times as high among cigarette smokers as among non-



OBSERVED	123	363	1058	4593	258	1460	30	231	175	669
EXPECTED	123	385	1058	2924	258	741	30	81	175	520

Figure 5.· Mortality Ratios by Major Causes of Death. Cigarette Smokers Compared with



smokers. Furthermore, the death rate was about five times as high for cigar smokers as for nonsmokers and about three-and-a-half times as high for pipe smokers as for nonsmokers.

Cancer of several other sites appeared to be associated with cigarette smoking, but the relationship was small as compared with the relationship between cigarette smoking and cancer of the lung and other sites directly exposed to cigarette smoke. Prominent in this respect were cancer of the bladder and cancer of the prostate.

Other Diseases

Coronary artery disease is of particular interest because: 1) it is the leading cause of death in the United States today, 2) because experimental evidence indicates that smoking has an acute effect upon the circulatory system, and 3) because for many years doctors have been under the impression that smoking has a bad effect upon patients with heart disease. In our study, coronary artery disease accounted for 5,297 deaths which was 44.6% of all the deaths reported. Figure 7 shows the relationship (in terms of mortality ratios) between cigarette smoking and death rates from this disease. The rates for men who smoked a pack or more of cigarettes a day were more than twice as high as the rates for nonsmokers. The rates for pipe smokers were about the same as the rates for nonsmokers and the rates for cigar smokers were only slightly higher.

Other types of heart disease did not appear to be related to smoking habits. However, deaths from a few circulatory diseases (such as aortic aneurysm) were associated to a moderate degree with cigarette smoking and one important circulatory disease (cerebral vascular lesions) was associated with cigarette smoking to a slight degree.

Death rates from peptic ulcers were highly associated with cigarette smoking. Several lung diseases showed an association and so did cirrhosis of the liver.

Death rates from accidents, violence and suicide were the same for smokers as for nonsmokers.

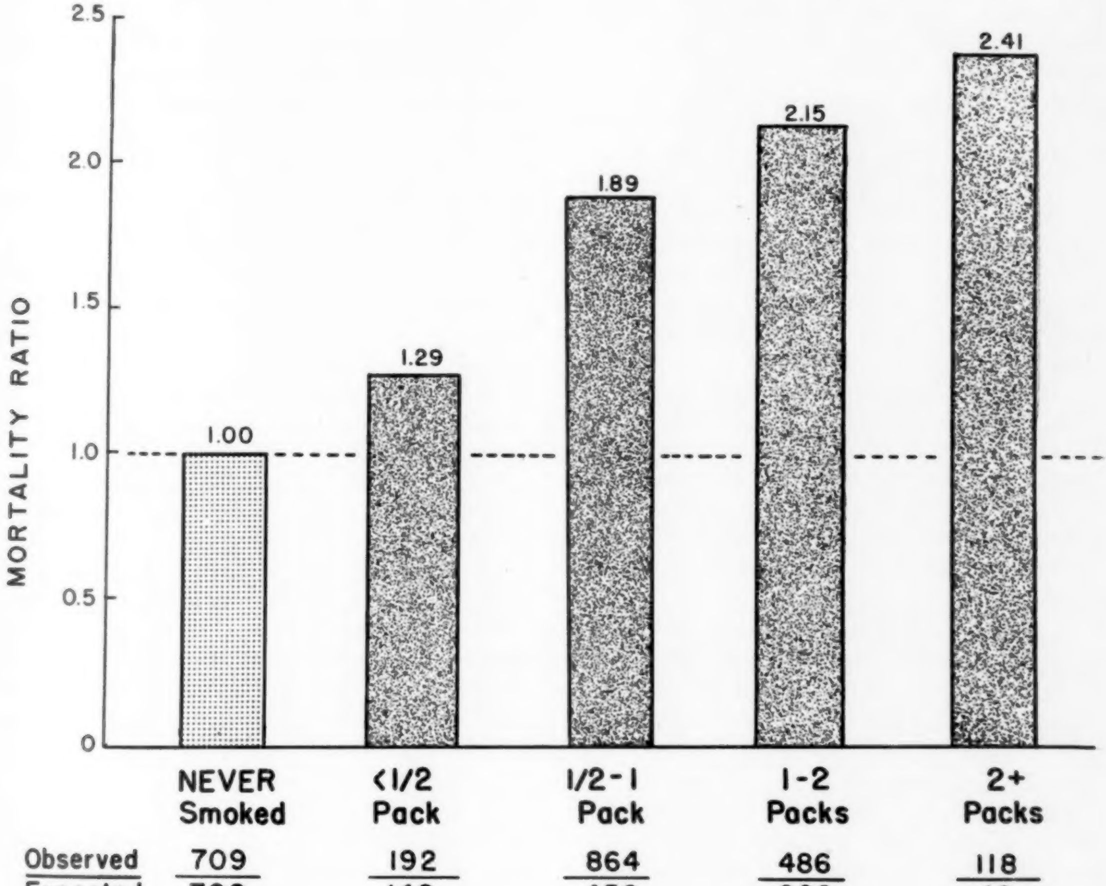
Other Studies

Two other studies very similar to ours have been carried out on smoking in relation to death rates from various causes. In 1951 Doll and Hill (12) mailed a questionnaire on smoking habits to all physicians registered in Great Britain and have been tracing them ever since that time. In 1954, Dorn (13) mailed a smoking questionnaire to veterans holding government life insurance and has traced them ever since. The results of these two studies were essentially the same as the results of our study. Furthermore, the results of these three so-called "prospective studies" are in agreement with the results of a large number of so-called "retrospective studies" previously described.

The difference between men and women in respect to lung cancer death rates has been the subject of considerable discussion. A study of smoking habits in a probability sample of the population of the United States has shown that among people over the age of 50, smoking is very much more common in men than in women, and few women in this age group smoke as much as one pack of cigarettes a day. (14) This is of interest since lung cancer seldom occurs in people less than 50 years old.

Some people have raised an objection to these studies on the grounds of "self-selection." That is, people decide for themselves whether to smoke or not to smoke, whether to smoke cigarettes or to smoke pipes or cigars, and how much they smoke. Conceivably, some inherited factor determines susceptibility to certain diseases, and conceivably people with a high susceptibility choose to smoke while those with a low susceptibility choose not to smoke. As has already been mentioned, it is hard to see how heredity could account for the great increase in lung cancer. However, this point has now been checked in another way.

Seventh Day Adventists, regardless of sus-



ceptibility to disease, refrain from smoking because it is against their religion to do so. Wynder and Lemon (15) have recently found that Seventh Day Adventists rarely develop lung cancer.

A factor which can lead to disease or premature death does not necessarily produce a feeling of ill health prior to the occurrence of definite disease. Indeed, some harmful drugs can produce a temporary feeling of well-being. Relatively little is known about the effects of smoking in this respect largely because feelings in relation to health are highly subjective and difficult to study.

Some people say that smoking "makes them feel good" or "peps them up" or "helps them to get going in the morning." This may be perfectly true. Perhaps it may be a direct result of the stimulating effect of nicotine. On the other hand, in a study of ex-smokers, a large majority said that they improved in some way (e.g., less coughing, felt better, etc.) after they stopped smoking. (16)

Recently, I obtained questionnaires on phyical complaints, habits, and other factors from several samples of men and women selected from the general population. About 12% of the nonsmokers (both men and women) said that they had a cough while 49% of the men and 65% of the women who smoked a pack or more of cigarettes a day said that they had a cough. In addition, a somewhat higher percentage of cigarette smokers than nonsmokers complained of shortness of breath. While coughing and shortness of breath are not necessarily serious complaints, they certainly do not contribute to the pleasure of living.

Some years ago, Diehl (17) made a study of smoking in relation to medical findings in students at the University of Minnesota. The mean grade on Schneider's cardiovascular physical fitness test was significantly lower among the smokers than among the nonsmokers.

Discussion

It is rarely possible to carry out any one single study which in itself will yield an absolutely conclusive answer as to whether a particular factor has an important influence on the occurrence of a particular disease or on case fatality rates from that disease. In most instances, final conclusions are based upon evidence of various types collected over many years by many different, independent investigators.

In my opinion, evidence now at hand is sufficient to conclude beyond reasonable doubt that cigarette smoking greatly increases the probability of developing cancer of the lungs and cancer of other tissues which are directly exposed to tobacco smoke or condensed material from tobacco smoke. Cigarette smoking may increase the probability of developing cancer of some other sites such as the bladder, but in my opinion the evidence on this point is not conclusive at the present time. There is convincing evidence that smoking has a deleterious effect on people with peptic ulcers or Buerger's disease. Personally, I think that cigarette smoking increases the death rate from coronary artery disease, perhaps by increasing the probability of developing the disease or perhaps by having a deleterious effect upon persons who have already developed the disease. The evidence suggests that cigarette smoking may have a bad effect in respect to a number of other diseases, but I would wish more evidence before drawing definite conclusions.

The question now is what if anything should be done about cigarette smoking.

Certainly, the happiest solution would be the development of a type of cigarette which would be harmless but at the same time pleasurable to smoke. The recent introduction of cigarettes with relatively low tar and low nicotine content in the smoke appears to be a step in the right direction, but we do not yet know whether they are much better than ordinary cigarettes from the standpoint of health.

Until and unless a truly safe cigarette is developed, the problem must be faced on an individual basis.

The problem is easiest for people who have not yet started to smoke cigarettes. They should consider well whether the alleged pleasure of cigarette smoking is worth the risk. They should also remember that they may find it extremely difficult to give up smoking once the habit has become established. If because of social pressures a young person feels that he must smoke, then, considering the evidence, he might decide to smoke a pipe instead of cigarettes.

The problem is more difficult for a person who has smoked cigarettes for many years and has trouble in giving them up. I can only suggest that he study the evidence concern-

ing the effects of cigarette smoking; weigh this against any benefit he thinks he derives from the habit; and then decide for himself what to do.

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Another Antibiotic

A new antibiotic, called tylosin, from a Thailand soil sample, has been reported to have promising possibilities in both agriculture and medicine. Preliminary animal tests indicate that tylosin stimulates growth in both swine and poultry and retards the growth of bacteria that cause chronic respiratory infections in poultry, said Dr. Robert L. Hamill, senior biochemist at Eli Lilly and Company, Indianapolis, Ind. The drug, which is now being tested for its value in a wide variety of animal and plant diseases is being investigated clinically for its effectiveness against staphylococcus and streptococcus infections, he stated. A unique quality of the compound is that, when allowed to stand in acid solution, it is converted into another antimicrobial, desmycosin, which demonstrates similar activity against bacteria.

"In the search for new antibiotics, soil samples are obtained from all over the world," Dr. Hamill observed. "One such sample was received from Thailand. From this soil was isolated a new strain of *Streptomyces fradiae* from which tylosin was produced."

New Booklets Available

Two new publications of the State Natural History Survey Division of Illinois have been announced as available for distribution. They are: *Food Habits of Migratory Ducks in Illinois*, Bulletin 27 (4):289-344, by Harry G. Anderson. Free until November 1, 1959, 50 cents after that date. *Night Lighting: A Technique for Capturing Birds and Mammals*, Biological Notes No. 40, by Ronald F. Labisky. Free of charge.

These are beautifully illustrated booklets which will be quite valuable for teachers interested in these topics.

A Study of College Introductory Biology Courses*

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VI. *Course Content*

A. Introduction

The swift progress of science has confronted the biologist with a great mass of vital material, a large part of which must be considered for inclusion in the course in elementary biology. For an efficient assimilation of this new material, a shift in emphasis may be needed.

The variation in presentation from course to course precluded an accurate estimation of the different kinds of introductory biology courses. Although some courses were built around a study of animal types, other courses were built upon concepts (the so-called "principles" courses), and still others employed an approach in which man and his relationship to the organic world was the central theme. The variation in the treatment of these and other organizational plans, and the gradations of treatment from one course to another were such that a consideration of this type of material was not included in this study.

In addition, presentation of subject matter varied from course to course; one course might have treatment in depth of a limited number of areas (the so-called "block and gap" method), other courses had a comprehensive treatment of great quantities of material, while others might have an ambitious program of outside readings of a wide variety of topics. Analysis based on this type of information was not attempted, as personal judgment would play too large a role in the evaluation of such material.

An article by Louis Lutz (15) describes the findings obtained from questionnaires sent to heads of zoology departments in a large number of schools. He states that "Animal Structure and Physiological Processes, respectively, are the two most important topics of course content used at the present time. Third place is divided between Classification and Reproduction, with the majority rating Classification third." He also stated that most schools gave the last place in importance to Heredity. It will be interesting to compare the opinions of instructors answering this questionnaire with the results of the analysis reported on the following pages.

Little direct information has been available for the comparison of the subject material incorporated in the biology courses at different institutions. It seemed, therefore, that a survey of such material might prove valuable. Included in the material made available at the institutions visited during this survey were outlines of courses, syllabi, and examinations. For a study of this nature, course outlines proved to be inadequate as they were often brief or in topic form, giving little indication of the breadth and depth of treatment. Moreover, some instructors stated quite frankly that they did not always follow their outlines.

It was thought that analysis of examinations might give an approximation of subject matter coverage. However, it is obvious that an instructor might refrain from testing material which he assumed all students knew, and that other material might not lend itself to certain types of testing and might be omitted. It was realized that there are other reasons to be critical of this type of analysis and caution had to be used in making too broad assumptions from these data.

It was assumed that a study of examination material would give more valid results than any other type of analysis.

B. Plan of Analysis

After a number of trial analyses, a list of the broad categories which might be covered in the examinations was prepared. These were sub-divided into 51 sub-categories. The list of categories is shown in Table 8. With objective examinations, or those mainly objective, each question was examined to determine the category or categories which it tested, as a single question often tested several categories. A record was kept of the number of times each category was tested. Analysis was made by a single person, in order to have uniformity. However, test runs were made by a second

*The first installment of this paper appeared in the October, 1959, issue.

person on a number of the examinations in order to validate the analytic process. Satisfactory agreement was found on this re-check of the analyses. Calculations were then made to determine the percentage of the entire examination which dealt with each category and sub-category (16, 17).

TABLE 8

List of Categories

I. *Science*
  1. Basic concepts, meaning of science, scientific method, philosophy
  2. Fields and scope of biology—general
  3. History of science
  4. Techniques of science—i.e., laboratory methods

II. *Ecology and related material*
  5. General, physical and biotic environment, interdependence, adaptation, dispersal, etc.
  6. Conservation
  7. Economic importance — human welfare (other than disease)

III. *Morphology (structural character)*
  8. Cells and protoplasm, products of protoplasm
  9. Tissues, organs, and systems

IV. *Classification, General Description of Organisms, including evolutionary morphology*
  10. General principles—Plants or Animals
  (Plants)
  11. Bacteria, Viruses, and Rickettsia
  12. Algae
  13. Fungi (except Bacteria)
  14. Bryophytes
  15. Tracheophytes, except the flowering plants (Lycopsida, Sphenopsida, and class Filicinacae of Pteropsida) (Pteridophytes)
  16. Flowering plants, Gymnosperms and Angiosperms (Spermatophytes)
  (Animals)
  17. Protozoa
  18. Porifera, Coelenterata, Ctenophora, Platyhelminthes, Nemertinea, Nemathelminthes, Trochelminthes (no coelom or pseudocoele)
  19. Echinodermata, Mollusca, Annelida (Chaetognatha, Bryozoa, Brachiopoda)
  20. Arthropoda—general
  21. Insecta
  22. All other classes of arthropoda
  23. Chordata—general
  24. Acrania (Sub-phyla-Hemichordata-Tunicata-Cephalochordata)
  25. Superclass Pisces — Amphibia — Reptilia — Aves
  26. Mammalia (other than primates)
  27. Primates

V. *Development*
  28. Cell division and germ cell formation (Mitosis, meiosis)
  29. Embryological development, growth and differentiation, regeneration

VI. *Heredity*
  30. Genetics, development, theory, history, etc.

VII. *Organic Evolution*
  31. Evidences for evolution
  32. Mechanisms of evolution

VIII. *Pathological Organisms and related material (factors in health)*
  33. Disease and its causation (life histories of parasites, insect vectors, etc.) (disease dissemination)
  34. Organisms' reactions to disease (effects of disease)
  35. Public health measures

IX. *Physiology*
  36. Chemical, Physical, and Physico-chemical properties of matter and protoplasm
  37. General physiological principles
  38. Animals — Nutrition and physiology of digestion
  39. Plants—Synthetic processes and nutrition
  40. General physiology of protoplasm, cells, and cellular metabolism
  41. Respiration (external)
  42. Circulation or transport in animals
  43. Special physiology of the higher plants
  44. Excretion
  45. Secretion (other than hormones)
  46. Nervous coordination
  47. Hormonal coordination
  48. Physiology of movement and support
  49. Behavior in plants and animals
  50. Physiology of the integument
  51. Reproduction

Examinations which were made up of subjective questions were treated differently. After considerable consultation, it was decided to weight these examinations on a percentage basis. Hour examinations were assigned a total of 100% while shorter or longer examinations were assigned a percentage based on the time allotted for the examination. The percentage assigned each question was then divided among the categories tested. Each question was analyzed independently by two people. After training it was found that here, also, there was good agreement on analysis.

An adjustment between the two methods of analysis was made with examinations composed of both types of questions. The information obtained in the analyses was recorded on punched cards, thus making it possible to collect various combinations of information readily.

No course was included in this analysis unless there was available at least a single set of examinations or a comprehensive final exam-

ination. In some cases there were sets of examinations which covered several terms. As examinations from only five Botany-Zoology courses and seven Physiology courses were available, these data will not be presented as the material constitutes too limited a sample.

C. Analysis of Main Categories

Examination material suitable for analysis was available for 92 courses in 44 colleges. In the 604 examinations which were processed; 65,027 units of information (points) were analyzed. The results are summarized in the following tables and figures.

As material on physiology was given the greatest emphasis in the majority of the courses, these data were given further consideration.

In each type of course except the general education biology, more courses were in the 26% to 35% range than in any other range. In the general education biology courses, more courses gave from 36% to 45% emphasis on physiological material than in any other range. This information is shown in Table 18. These data indicate a trend which should be given serious attention. It is questionable whether an introductory biology course should have so much physiological material that it begins to approximate an introductory course in physiology. It is apparent that many important, interesting, and vital areas of biology must be omitted if so much physiological material is included in the beginning course.

Figure 10 represents graphically the medians of coverage for all main categories in all types of courses. This reviews the material in the preceding figures and allows comparison of the medians of one type of course with another.

The moderate emphasis on science and lesser emphasis on ecology show clearly. Greater emphasis on morphology and still greater emphasis on classification are obvious. However, the lesser emphasis on classification by the general-education biology and integrated biology courses can be noted. The moderate amount of material on development and heredity and still less material on organic evolution can be seen. The very small amount of material on factors in health and related subjects is apparent. The disproportionate amount of physiological material has already been discussed and shows here very clearly.

VII. *The Biology Laboratory*

A. Types of laboratory exercises

For this portion of the survey, is was possible to observe laboratory sections of most of the colleges visited. In addition, laboratory outlines, syllabi, and nearly one hundred laboratory manuals used in the courses visited were available.

In a moderate number of the courses visited, commercially prepared laboratory manuals were in use. The majority of the instructors preferred to develop their own laboratory

TABLE 9
Coverage of Science in Examinations

Type of Course	Number of Courses	No. Courses omitting Category	Minimum per cent Coverage	Maximum per cent Coverage	Median per cent
Int. Biology	14	0	0.8	19.1	7.3
Gen. Education	18	0	0.2	36.4	8.3
Zoology	29	0	1.4	24.4	5.6
Botany	19	0	2.7	41.2	11.0

TABLE 10
Coverage of Ecology in Examinations

Type of Course	Number of Courses	No. Courses omitting Category	Minimum per cent Coverage	Maximum per cent Coverage	Median per cent
Int. Biology	14	C	0.5	13.9	4.0
Gen. Education	18	2	0	9.6	2.5
Zoology	29	3	0	7.1	2.0
Botany	19	1	0	9.7	3.2

TABLE 11
Coverage of Morphology in Examinations

Type of Course	Number of Courses	No. Courses omitting Category	Minimum per cent Coverage	Maximum per cent Coverage	Median per cent
Int. Biology	14	0	7.1	32.0	14.9
Gen. Education	18	0	2.4	32.8	14.6
Zoology	29	1	0	39.0	14.2
Botany	19	0	8.4	23.4	17.5

TABLE 12
Coverage of Classification in Examinations

Type of Course	Number of Courses	No. Courses omitting Category	Minimum per cent Coverage	Maximum per cent Coverage	Median per cent
Int. Biology	14	0	1.4	31.7	14.0
Gen. Education	18	1	0	36.0	10.5
Zoology	29	0	7.1	62.8	23.4
Botany	19	0	15.5	66.3	26.2

TABLE 13
Coverage of Development in Examinations

Type of Course	Number of Courses	No. Courses omitting Category	Minimum per cent Coverage	Maximum per cent Coverage	Median per cent
Int. Biology	14	0	2.2	22.4	8.2
Gen. Education	18	0	1.2	12.2	6.5
Zoology	29	0	0.9	14.8	7.3
Botany	19	0	0.7	13.9	5.2

TABLE 14
Coverage of Heredity in Examinations

Type of Course	Number of Courses	No. Courses omitting Category	Minimum per cent Coverage	Maximum per cent Coverage	Median per cent
Int. Biology	14	0	2.4	16.8	6.3
Gen. Education	18	1	0	20.2	5.5
Zoology	29	3	0	36.6	5.5
Botany	19	2	0	17.7	3.8

directions. It was interesting to find that most of the instructors had the sheets of directions bound into a single volume. Thus the student was able to prepare for the assignment before coming to the laboratory. In some cases, instructors gave the students directions for each day's assignment at the beginning of the laboratory period.

Difference of opinion exists regarding desirable laboratory exercises and possible level of student achievement in the laboratory. The following representative statements reflect the views of the majority of instructors: "The basic function of the laboratory is confirmatory." "Laboratory is usually confirmation." "The students are not proving things, they are dramatizing them." "...Tend a little more to verification—not due to its desirability, but because experimental types of laboratory tend to be difficult technically."

Comparison was made of student achievement expected, of different types of exercises used, and of the reasoning necessary for the successful completion of laboratory assignments. There was great variation in techniques used and in effectiveness of the programs planned for the laboratory.

In agreement with the opinions quoted above, it was found that simple verification was the usual type of laboratory assignment. Such exercises generally involved observation of a specimen and recording the observations by making a drawing or labelling a diagram. Even though this type of exercise was common, it does not follow that it is the best procedure. Nevertheless, the usual practice of dissection and study of a series of organisms may be an effective teaching device. Under the guidance of an experienced instructor, the students may be led to draw various conclusions and apply the knowledge they have gained. When such work is directed by an inexperienced instructor it often is completely stultifying. The economies in instructional expense, in time in preparation, and in material and equipment needed, make the simple verification exercise attractive to both instructor and administration.

Simple verification exercises are often modified by the addition of questions the student is expected to answer. The questions often concern physiolgical processes and frequently, the only physiological material included, was

TABLE 15
Coverage of Organic Evolution in Examinations

Type of Course	Number of Courses	No. Courses omitting Category	Minimum per cent Coverage	Maximum per cent Coverage	Median per cent
Int. Biology	14	1	0	10.0	2.9
Gen. Education	18	0	0.2	16.8	3.0
Zoology	29	5	0	9.6	1.9
Botany	19	11	0	7.3	0

TABLE 16
Coverage of Pathological Organisms in Examinations

Type of Course	Number of Courses	No. Courses omitting Category	Minimum per cent Coverage	Maximum per cent Coverage	Median per cent
Int. Biology	14	2	0	14.4	1.3
Gen. Education	18	1	0	7.3	2.2
Zoology	29	4	0	6.4	2.1
Botany	19	9	0	3.3	0.1

TABLE 17
Coverage of Physiology in Examinations

Type of Course	Number of Courses	No. Courses omitting Category	Minimum per cent Coverage	Maximum per cent Coverage	Median per cent
Int. Biology	14	0	24.7	49.0	33.1
Gen. Education	18	0	19.0	60.7	39.0
Zoology	29	0	5.5	51.4	31.0
Botany	19	0	7.4	35.7	26.8

TABLE 18
Frequency Distribution of Coverage of Physiology in Each Type of Course

Number of Courses	Type of Course	Percentage of Physiology Coverage					
		6%-15%	16%-25%	26%-35%	36%-45%	46%55%-	56%-65%
14	Integrated Biol.	0	1	8	3	2	0
18	Gen. Ed. Biol.	0	3	4	8	1	2
29	Zoology	1	5	14	6	3	0
19	Botany	2	6	10	1	0	0
—		—	—	—	—	—	—
80		3	15	36	18	6	2

FIGURE 1

I SCIENCE

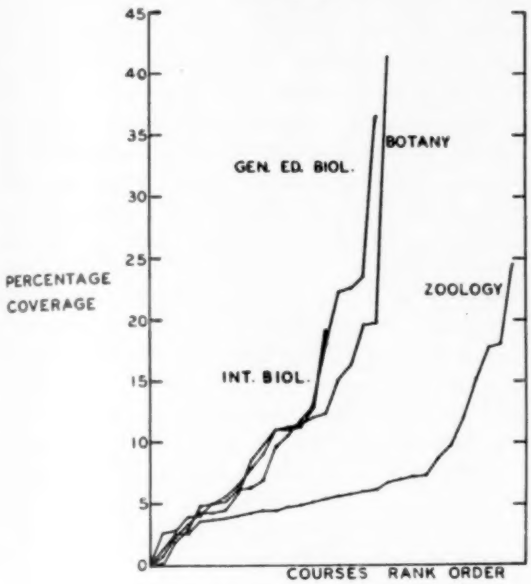
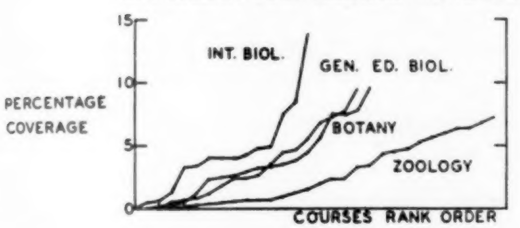


FIGURE 2

II ECOLOGY AND RELATED MATERIAL



represented by such questions.

Quite often a course was made up of a large number of verification exercises with some experiments of somewhat different nature. Among the added experiments physiology was generally represented by a few experiments on photosynthesis and digestion. Also exercises on embryology, genetics, and bacteriology were sometimes included.

In a moderate number of cases, the emphasis was reversed and there were a large number of exercises such as those just described and less of the simple verification exercises. All of the laboratory programs just described were similar in one respect; observation and recording were the primary tasks set for the student. Successful completion of the work often could be accomplished with minimal mental effort.

It is the responsibility of the instructor or administrator to decide on the type of work expected of the students. The skepticism of the

FIGURE 3

III MORPHOLOGY

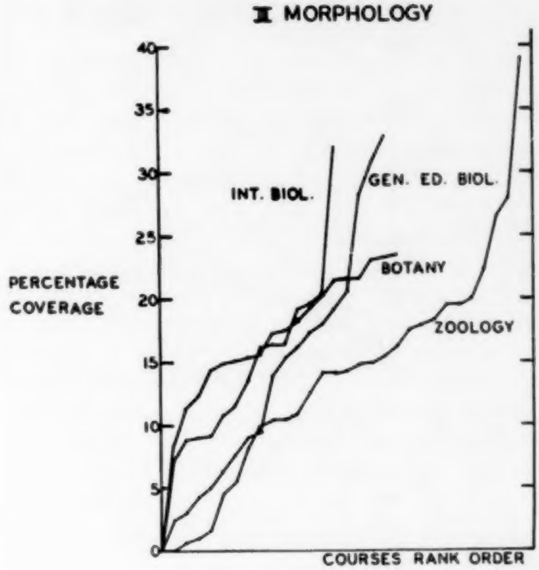


FIGURE 4

IV CLASSIFICATION

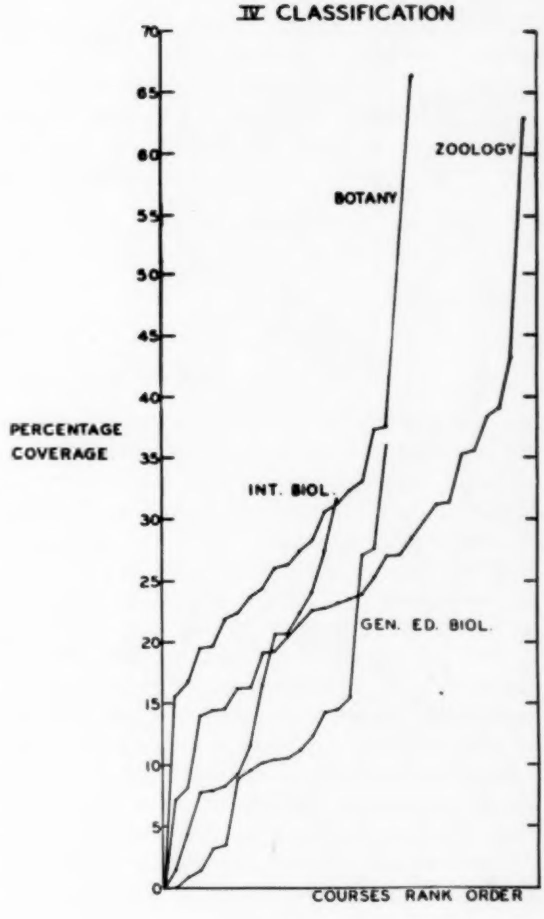


FIGURE 5

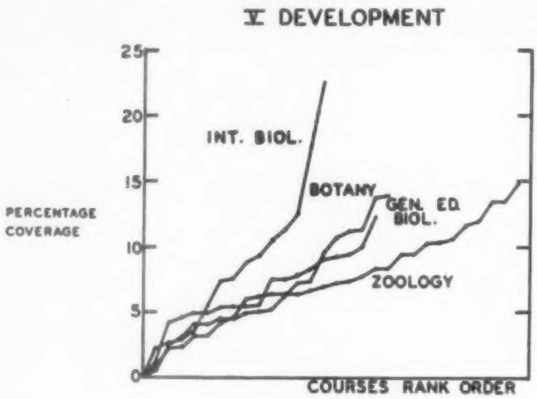
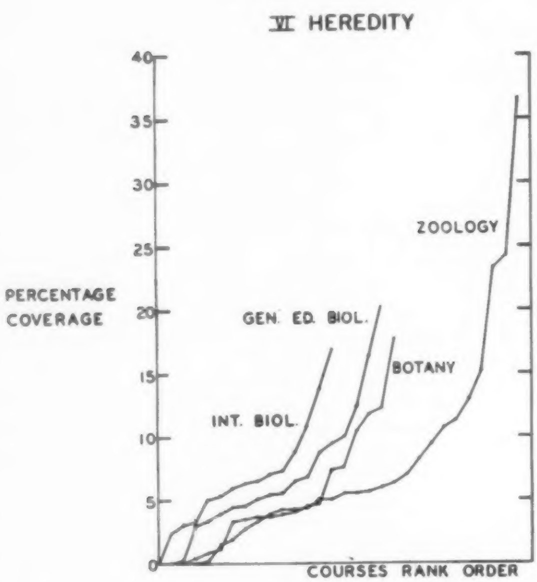


FIGURE 6



majority of the instructors as to the capabilities of the beginning student and his ability to do difficult laboratory work was not confirmed. Evidence of ability, interest, and proficiency of the beginning student when given greater opportunity in the laboratory was clearly demonstrated in some long-established courses as well as in courses developed more recently.

The exercises in these older courses reflected the results of long experience, planning, and the instructor's interest in developing the abilities of the students. In these courses there were exercises which coordinated different areas of knowledge and which were extremely effective in promoting interest and learning. Proof of such effectiveness was shown by choice of profession and subsequent achievements of the students who had completed these courses. Among the institutions where such courses were observed were a women's college, a men's college, co-educational institutions of small and moderate enrollments, and a large co-educational university.

In courses of more recent development, special types of presentation have been introduced. Varying practices exist, such as exemplification of the scientific method, discovery-discussion types of presentation, as well as other methods, but in one respect there was similarity. All of these courses utilized a greater number of experiments in which reasoning is involved in gaining knowledge and in which the student is expected to discover, rather than to confirm. There was a strong tendency to employ physiological material as it is adapted to this type of exercise. Unless this material is used with restraint it could transform a beginning biology course into a simple course in introductory physiology. However, this need not occur as excellent exercises emphasizing other aspects of biology were observed. Some outstanding exercises were developed on genetics, biotic associations, adaptations, other ecological concerns, learning behavior, embryology, taxonomy, and other subject matter.

FIGURE 7

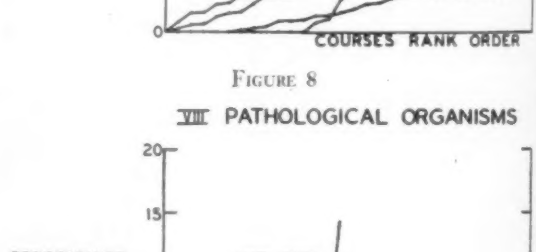


FIGURE 8

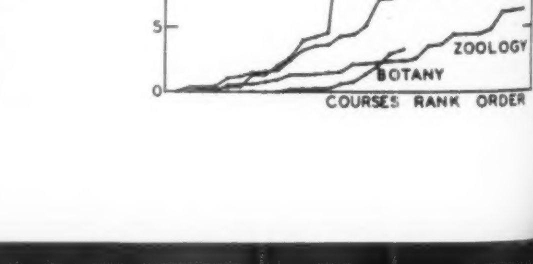
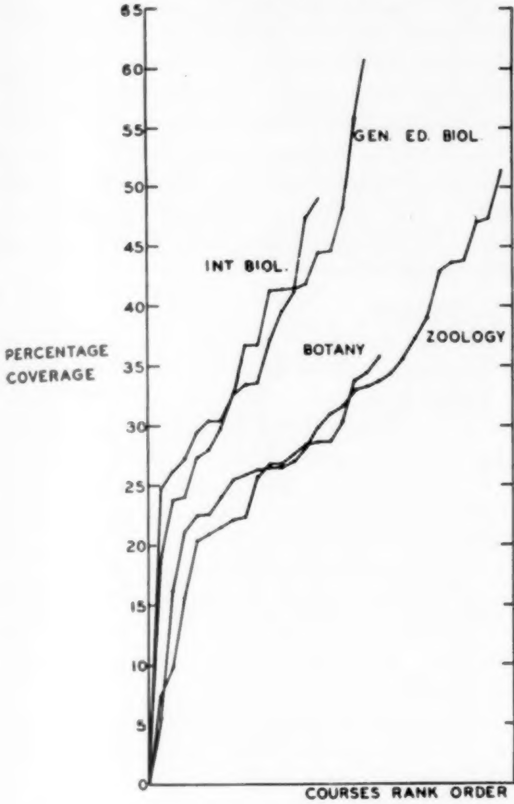


FIGURE 9

IX PHYSIOLOGY



In one instance, material was transformed from simple verification by the study and comparison of two organisms in a single exercise.

The characteristics of various organisms and their relationship to each other are generally learned piecemeal. The student learns characteristics as he is introduced to each animal or plant group. In a few courses, a "keying" exercise for either plants or animals is utilized. In some, the students are led to develop a key, and in others, a simple key is provided. In both cases the instructors felt that the students gained a much better understanding of the relationships of one group with another.

In a number of laboratory manuals, well planned "Data Sheets" or "Record Sheets" are included. In order to complete the experiment successfully, the student must make assumptions and draw conclusions.

Although the majority of these recently developed courses were found at larger coeducational universities, this type of laboratory instruction was also seen at a women's college, several men's colleges, and some smaller universities. While there was variation in the instructional techniques among these courses, there were certain common attributes. In all these courses there was a willingness to experiment with established laboratory procedure. There were frequent opportunities for discussion among the various instructors, and there was a definite plan for the evaluation of the program.

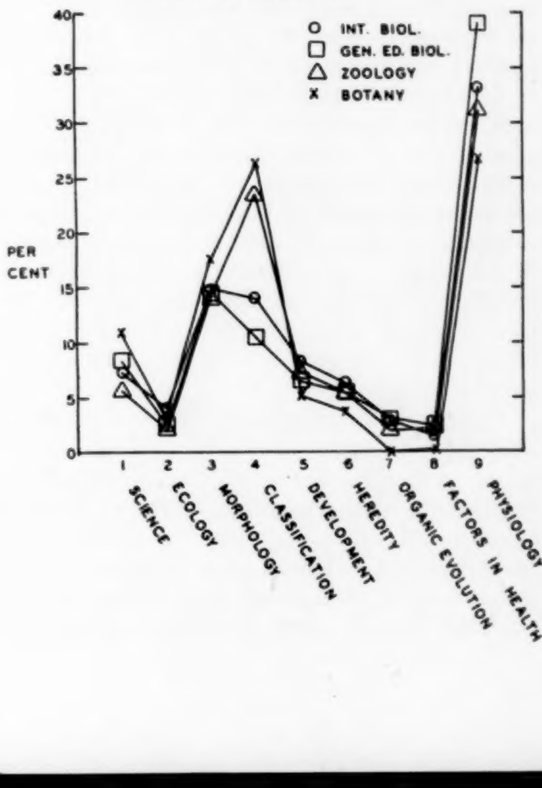
The evidence presented here indicates that the greatest improvement in course work can be made in the laboratory portion of the course. In any course, the plan of work in the laboratory should be subjected to critical appraisal. An attempt should be made to develop the full possibilities of work in the laboratory. A critical evaluation of the material utilized and of the most desirable methods of instruction is necessary.

B. Laboratory teaching and organization

The organization of the staff and their assignments in the laboratories varied in different institutions. Some administrators required that a member of the faculty be available in the laboratory at all times even though assistants were also present. At some institutions, laboratory meetings under the supervision of a single instructor were held in

FIGURE 10

MEDIANS OF PERCENTAGE COVERAGE
MAIN CATEGORIES



adjoining rooms, with assistants assigned to each room. In institutions where many laboratory sections met at the same time, it was a common practice for the graduate assistants in charge of each section all to be under the supervision of one instructor.

At one large university an excellent plan for administration of the laboratory program is in use. Each semester an experienced graduate student is appointed "Acting Instructor." During his tenure he receives higher renumeration and does not elect any formal course work. The acting instructor serves as the link between the professor in charge of the course and the teaching assistants. He plans laboratory work, holds conferences with the teaching assistants, and thus the success of the laboratory program is his responsibility. The manner in which the acting instructor performs his task will determine, in part, the type of recommendation he receives subsequently. Obviously, this plan promotes excellent motivation and efficiency.

At several institutions, when a new laboratory assignment is begun, the inexperienced laboratory instructor shares a laboratory section with a person of more experience. Subsequently, the newer instructor may have charge of a section by himself or with another person.

It was found that there generally was supervision and training of the individuals concerned with instruction in the laboratory, although it was not a universal practice. A surprising number of laboratory sections were in charge of inexperienced personnel.

In some institutions the instructors with professorial rank take charge of the laboratory sections. At one institution, the entire department participated in the laboratory instruction as the beginning course was the responsibility of the entire staff. There were always two instructors present at each meeting of the laboratory sections. The level of achievement attained by the students in this course was unusually high.

The efficiency of teaching in the laboratory depends also on the number of students assigned to each laboratory instructor (graduate assistant, or under-graduate assistant) in each laboratory section. In some cases instructors were expected to help a very large number of students. The mid-point in our data shows eighteen students per instructor. Those instructors with the heavier student loads were unanimous in condemning the situation. It is obvious that more can be accomplished with the smaller number of students.

In some departments there were employees who took charge of all the details of laboratory preparation. Sometimes these preparators were highly skilled and were able to perform difficult technical work. In many of the courses in which there were extremely well organized laboratory programs there was adequate assistance available.

C. Projects

The assignment of required projects is not a common practice. However, this did occur at a few institutions and appeared to be of real value. Some of the projects submitted by the students required only a moderate amount of time. In one institution the students must submit a large insect collection. At another, course work is suspended for two weeks, during which the students are expected to complete their projects. Prizes are awarded for the best work. At another institution one fourth of the year's work is devoted to student projects.

All the courses in which there were projects were notable for the effectiveness of teaching and the enthusiasm of the students. However, it might well be that the latter was a reflection of the strength and enthusiasm of the individual instructor.

D. Laboratories and equipment

Extremely well equipped and well planned laboratories were seen at many institutions. In only a small number was instruction handicapped. Some laboratories were outstanding in the excellent arrangement of preparation rooms and display rooms in conjunction with the laboratory.

Lack of adequate display space was common at most colleges. Some institutions have excellent display cases either in hallways or in special museum rooms. Where these were available, the students were able to make use of the material at their leisure.

Greenhouses and animal rooms were an integral part of the equipment of the biology laboratory in most of the institutions visited.

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16. A grant from the Survey of Physiological Sciences made this work possible.
17. This was made possible by a grant from the National Science Foundation.

Biology in the News

BROTHER H. CHARLES, F.S.C.

BARRELS OF RATTLERS, David Brazil, Outdoor Life, July, 1959, pp. 44-47, 97-99.

Vivid experiences of a hunter of rattlers. Not to be imitated except in his great care to protect himself.

THE SECRETS OF LONG LIFE, Dr. George Gallup and Evan Hill, Saturday Evening Post, August 15, 1959, pp. 17-19, 42-50.

Americans have an ever-increasing life term expectancy. Why? Dr. Gallup secures some answers by polling the oldsters. The first of three articles on the subject. A possible source and stimulus for discussion.

THEY HUNT THE MYSTERIOUS MENHADEN, Tom Alexander, Saturday Evening Post, August 22, 1959, pp. 26-27, 53-56.

Though the take of menhaden is greater than that of any other fish, we know little of its habits and why it is sometimes plentiful and at other times scarce. The uses of this fish are described, too.

IN PRAISE OF WASTE, Garrett Hardin, Saturday Evening Post, August 29, 1959, pp. 18-19, 81-83.

Do you ever think of mutations, most of which are harmful, as waste? And are experiments in science waste, also? The author presents many thought provoking ideas which your very best students will grasp and appreciate.

THE ASTRONAUTS—READY TO MAKE HISTORY, Life, September 14, 1959, pp. 26-43.

This article contains much extraneous material but the text and pictures give an excellent idea of what the human body can stand. It also illustrates some of the careful detail necessary to insure the success of the project.

FALLOUT: THE SILENT KILLER, Steven M. Spencer, Saturday Evening Post, August 29, 1959, pp. 26-27, 87-90.

HOW SOON IS TOO LATE, Steven M. Spencer, Saturday Evening Post, September 5, 1959, pp. 25, 87-90.

How concerned should we be about the amount of radioactivity in the air, in our food and water. Are the biological risks worth taking to develop our knowledge of nuclear power? These two articles present a considerable amount of pertinent information, raise a lot of questions and should stimulate your sutdents to further reading on this important subject.

YOU AND YOUR DOCTOR, Warren R. Young, Life, October 12, 1959, pp. 144-160.

Many people have unhappy attitudes toward physicians. This article discusses some of the causes of these attitudes and offers some suggestions for obtaining treatment as a person and not as a simple disease entity. It should be read by any student who hopes to become a member of the healing profession.

Another publication which will be of interest to those who like to keep track of what is going on in the great out-of-doors, is the new *Western Outdoor Quarterly* which is published by the Federation of Western Outdoor Clubs. Membership in the organization is $2.00 per year, and inquiries should be addressed to 50 Molino Avenue, Mill Valley, California.

Cooperative Committee (AAAS) Recommendation for the Preparation of High School Teachers of Science and Mathematics–1959*

Biology Section

The concern for better preparation for teaching in the field of science and mathematics (hereafter referred to in this report as the sciences) has been growing during the last several years. Very recently this concern has been intensified considerably as the result of new developments both nationally and internationally. A statement was made by the Cooperative Committee of the AAAS in 1946 with reference to recommended minima for the preparation of science teachers in content material.[1] In that same report a general statement was given with reference to the breadth of preparation that was to be desired.

I. *Purpose.* It seems that it is now time (1) to re-examine our original statements, (2) to take cognizance of the impact of those events that have transpired in the last ten years on the requirements for the preparation of science teachers and (3) to make additional recommendations which result from the demands of the changing circumstances.

It is well recognized that changes in state certification laws may not always be made quickly. It is our hope however, that this information and these recommendations, even though not immediately written into certification codes will be studied by college and university departments of education, teacher's colleges, state departments of education, certification bureaus and accrediting agencies, school administrators who select science teachers, colleagues in subject matter areas, and finally by those students and teachers who are preparing to do a more effective job in teaching science in our secondary schools.

II. *New developments to be considered.* Several important factors have influenced the type of recommendation we now make on the course content that prospective teachers should have.

1. *The rapid changes that have occurred in a number of the sciences in the last decade.*
   Chemistry, physics, biology, astronomy, meterology, mathematics, and geology have all advanced considerably in the last ten years. Word of new advances spreads by newspapers, magazines, public lectures, and television. This stimulates the curiosity of students who then seek answers to many questions. Teachers must be prepared to stimulate further the interest in such questions, to provide sound answers for them, and to direct effective reading at the level of the student's background. The course work taken by the teachers should prepare them to keep abreast of the new developments which are often highly complex and to answer questions about them, and to direct discussion of them.
2. *College entrance with advanced standing.*[2] A concerted move was made (beginning in 1954) by a number of the fine colleges and universities of this country to work with secondary schools in developing college-level courses for their most able students. In the resulting program, for example, mathematics starting in the 10th grade leads to calculus in the 12th. In chemistry, the time-equivalent of at least three semesters permits instruction at the college-level using college texts. Thus students qualify for sophomore courses on college entrance thereby reducing duplication. In physics similar

*The complete text of this report has appeared in *School Science and Mathematics*, April, 1959 issue.

[1]School Science and Mathematics, February 1946.

[2]Bulletin on Advanced Placement Program, College Entrance Examination Board, 425 W. 117 Street, New York, N. Y. Norton, Bayes, "College Admission with Advanced Standing;" J. Chemical Education, Vol. 33, pages 232-237 (1956).

programs have been available, but unless calculus is also taken, the policy has been to recommend the advanced mathematics instead of advanced physics, thus making it possible for the student to start his sophomore physics (using calculus) during the freshman year in college. Similar programs have been in effect in biology, English, languages, and history. This program, expressing confidence in our secondary schools, lays emphasis on the results of good teaching in high school which in turn may be rewarded by credit toward college graduation, or time for more advanced work in college. This reward is made on the basis of the college level course programs referred to above and on examinations prepared and graded by committees of school and college teachers. Selected groups of college freshmen have taken the same examinations for use in setting grade standards. In 1954 candidates were examined from 18 schools (9 public, 9 private). In 1957 more than two hundred schools participated.

3. *Demonstrated proficiency vs. "16" credits.* More and more of the colleges and universities are emphasizing demonstrated proficiency in subject matter areas rather than simply permitting entrance to the college with "sixteen" high school credits or a certain number of academic units. More and more we find colleges over the country adopting some kind of entrance examination as part of the method of selecting their students.

4. *More content courses to meet the problems of complexity.* The increased complexity of the fields of science produces more impact upon the importance of content material to make it possible for the teacher to answer the "why" type of question rather than to just teach the material empirically.

There may be other factors but certainly these are some which should be recognized.

2. *The recommendations are:*
   1. A policy of certification in closely related subjects within the broad area of science and mathematics should be established and put into practice.
   2. Approximately one-half of the prospective teacher's four-year program should be devoted to courses in science.
   3. Certification to teach general science at the 7th, 8th, and 9th grade level should be granted on the basis of a broad preparation including college courses in all the subjects concerned in general science.
   4. Colleges and certification authorities should work toward a five-year program for the preparation of high school teachers.
   5. Curriculum improvements in the small high schools should go hand in hand with improvement in teacher preparation.

III. *Pertinent considerations.* In formulating a set of recommendations for the training of high school teachers of science we are immediately confronted with several conflicting circumstances.

First; most science teachers are required to teach several sciences including, perhaps, a course in general science, rather than just one science. This means that a teacher must have depth of preparation in a variety of areas.

Second; because of the impact of science on other areas, the science teacher should have preparation in the social sciences and humanities to help give him the kind of perspective that we like the top-rate scholar and citizen to have.

Third; there are certain elements in professional education which should be helpful in giving the best performance in the classroom. These elements may be provided by courses in such areas as the psychology, philosophy, and methodology of education and especially by experience in student teaching.

The Problem. Our problem then, is (1) to recognize, in a very objective manner, the role of these several new developments in the last decade, (2) to recognize the problems that we face in building a realistic academic program for preparation of science teachers and (3) to make recommendations with reference to the best type of program that can be achieved to meet these changing needs.

The academic program to meet these three facets of our problem will certainly be a full one. However, assuming a minimum of 120 semester hours of academic work for graduation, these requirements may be met and still

leave approximately one half of the student's academic program free for the humanities, social sciences, and professional educational courses Many students can or will have more than 120 hours of academic credit. One half of the student's time for preparation in his teaching area seems reasonable to expect if he is to be properly prepared. Furthermore, this amount of concentration can give him such depth that it will be possible for him to build on it later with a fifth year or more of content material to further improve his competence in the science area.

In all of this planning to build a program to train science teachers it seems almost impossible to plan a satisfactory four year program to prepare teachers to teach in widely divergent areas: for example, English teachers to teach physics, or social science teachers to teach chemistry, or physical education teachers to teach mathematics. On the other hand, if multiple teaching assignments are necessary, some favorable combinations are physics and mathematics, chemistry and physics, and biology and health.

IV. *Recommendations for Each Science Area.* The courses which are recommended in each teaching area, together with supporting courses, are outlined in the following sections. Each course is designated in terms of semester hours of credit; this designation is intended only to indicate the general proportion of time and the minimum requirements.

The supporting courses which are recommended should be the basic courses in that science area, and not the survey courses, and should in each case include laboratory work.

The earth science course should contain, not only the elements of geology but also some topics relating to meteorology, physical geography and astronomy.

The description of each course in the following sections is merely suggestive or illustrative of the possible topics and makes no attempt to suggest all that could or should be included.

The committee realizes that the programs recommended here do not guarantee an inspiring teacher but they should help.

Part 1.—SUGGESTED COURSES IN BIOLOGY AND OTHER SCIENCES FOR THE PREPARATION OF HIGH SCHOOL TEACHERS OF BIOLOGY

(Given in semester hours)

Suggested Courses (See notes Below)	A	B	C	D	E	4-year total	5th year	5-year total
Biology	10	8	4	4	4	30	12	42
Chemistry						12	4	16
Physics						8	4	12
Earth Science						3	—	3
Mathematics						6	2	8
totals						59	22	81

Notes on Part 1:

1. *Descriptions of Biology Courses.*
   A. *Principles of Biology.* Characteristics of living organisms, cell theory, structural system of plants and animals, metabolism, maintenance of individual, (health and disease).
   B. *Plant and Animal Physiology and Anatomy.* Morphology, study of tissues, functional activities of cells and tissues, reflexes and tropisms, functional units of systems, catalysts, and enzymes.
   C. *Ecology and Conservation.* Environment, soil, populations, relationships of species, distribution of communities. Field work should be an integral part of this course. This course could be coordinated with the work in Earth Sciences.
   D. *Developmental Anatomy and Genetics.* Growth and development, principles of heredity, evolution.
   E. *Preparation and Use of Biological Materials.* This course should be conducted by one conversant with the problems of biology teachers. Consideration must be given to teaching techniques peculiar to biology. Preparation and proper use of demonstration and laboratory materials, teaching aids and methods should be emphasized.
2. *Fifth Year.*
   There should be a minimum of mandated semester hours in biology, to permit more flexible selection of the courses which will be of most benefit to the teachers. "Cultural" courses in general science should be allowed (history of science, problems of

atomic age, laboratory techniques in more than one science; et. al.). However, 25% of this year should be devoted to definitely biological topics, such as radiation biology (see physics courses), microbiology, taxonomy, and training in microtechnique. It is to be understood that more courses in biological sciences should be encouraged as electives.

3. *Description of Courses in Other Sciences Recommended for Biology Majors.*
Principles of inorganic and organic chemistry, particularly as it applies to living things. Laboratory work should be included. Biochemistry is recommended in the fifth year. Standard courses in physics, earth science, mathematics are expected.

V. *Miscellaneous:*

1. *The science methods course.*

It is assumed that a science methods course will be available in each of these curricula. The two essential conditions for this to be a valuable course are centered in the qualifications of the instructor. He must be a person who is a scholar, well and solidly informed in the field of science, and he must be cognizant and intelligently sympathetic toward the problems of secondary education. Given these qualities as a sine qua non, the question of the department of school in which the course should be taught becomes irrelevant and is a matter to be decided in terms of local institutional circumstances.

2. It is hoped that the students will receive training in the preparation and planning of materials for laboratory work and demonstration purposes.

3. *The fifth year.*

A fifth year of work is strongly recommended. At least half of the course work during this year should be in science courses.

4. *Earth science.*

The elements suggested for inclusion of the earth science course are enumerated in Section IV. No statement is made about preparation of teachers to teach earth science alone. Recommendation for preparation of teachers in such basic sciences as chemistry, physics, biology, mathematics, and physical or general science has been considered of major concern at this time.

5. *Credit to Maintain Certification.*

Teachers who are required to take a certain number of credit hours work to maintain their certificates after several years of teaching should take this work in their teaching field unless they already have sufficient background of basic and recent course work in that field.

6. *A synoptic view.*

A survey of the requirements for the five science majors in this report (biology, chemistry, physics, physical science, and general science) shows that there exists a pattern of background common to all. Thus, each science major can be thought of as consisting of this common foundation plus certain additional preparation.

Specifically, the pattern of background common to all of the science preparations (but not including preparation for mathematics teaching) is:

Biology	6
Chemistry	8
Physics	8
Earth Science	3
Mathematics	6
Total	31

Because there is so much in common among these five curricula, it is quite practical for the prospective teacher to qualify in at least two of the five science areas involved in this report. Specifically, it is quite practical for the prospective teacher of biology, chemistry, physics, or physical science to add a few more courses and qualify also as a teacher of general science. This combination, known in some places as a "comprehensive science major," is an ideal preparation for the modern teacher of science to high school students.

For the four year programs, the requirements are summarized in the table below. This synthesis of recommendations also suggests multiple qualification in secondary school science; for example, a teacher prepared in biology could also qualify in general science by taking four additional units in physics and three additional units in earth science.

The Sub-Committee of the Cooperative Committee of the American Association for the Advancement of Science:

Wayne Taylor, University of Texas, Austin, Texas

Henry W. Syer, Kent School, Kent, Massachusetts

S. Winston Cram, Kansas State Teachers College, Emporia, Kansas

Fred Dutton, Michigan State University, East Lansing, Michigan

Harold E. Wise, University of Nebraska, Lincoln, Nebraska
Bro. G. Nicholas, La Salle College, Philadelphia, Pa.
Robert Stollberg, San Francisco State College, San Francisco
Alfred B. Garrett, Chairman, The Ohio State University, Columbus, Ohio.

	Common Foundation	Major in				
		Biology	Chemistry	Physics	Physical Science	General Science
Biology	6	24	2			4
Chemistry	8	4	20	5	10	
Physics	8			17	10	4
Earth Science	3				2	3
Mathematics	6		6	7	7	
Subtotal		28	28	29	29	11
Common total		31	31	31	31	31 + 18*
Grand Total		59	59	60	60	60

*18 units upper division work selected from two or more of the four science fields (excluding mathematics) listed above.

The Cold

The common cold will be at least 30 times as hard to conquer as polio has been, according to a *Chemical and Engineering News* report on the development of vaccines to combat colds. All the viruses isolated from colds so far do not account for more than 30 per cent of all colds, the report indicates.

The common cold, which can be defined as "a disorder in which a person has a runny nose two days in succession but little or no fever," has been found to be an extremely complex, ever changing problem. Colds are caused by dozens of different strains of viruses and, apparently, by many viruses not yet isolated. These viruses are capable of mutating, or changing, which makes the job of finding and fighting them very difficult. Furthermore, many "rip-roaring colds" are simply the first stages of mumps, pneumonia, chicken pox, or polio, which the sufferer has the resistance to fight off after this initial stage. Cold symptoms also may result from bacterial infections or allergies.

One researcher thinks a vaccine that will prevent 60 to 70 per cent of all common colds will be available within two years. Some are much less optimistic, talking in terms of 10 to 15 years. The polio vaccine, which is considered highly successful, is about 80 per cent effective, but it contains only three inactivated viruses and deals with a much simpler problem.

A person may have five colds in a single season, exactly the same in symptoms, but each caused by a different organism. It may be that, in a given area in a given season, only a few viruses are the cause of the cold problem. This may even be true nationwide. On the other hand, some observers doubt whether any one virus causes more than about 10 per cent of the nation's colds in any one year.

Scientists working for the vaccine manufacturer have the basic job of isolating the pure virus strain, producing it in large enough quantity, inactivating it, and putting it into a safe vaccine. One of the practical limitations is the number of antigens that can be purified and squeezed into a single hypodermic shot. One 15-antigen shot has already been developed. Twenty antigens in a single shot would constitute "a heroic effort," but they might also begin to interfere with one another.

There were 24,830 pedestrians injured crossing intersections *with* the signal in their favor during 1958 in the United States.

In 1958, more than 49 per cent of the traffic injuries resulted from weekend accidents.

Nominations for 1960 Officers

NATIONAL ASSOCIATION OF BIOLOGY TEACHERS

In accordance with the constitutional provision on elections, a nominating committee consisting of five classroom teachers was appointed by President Paul Klinge. The committee consisted of Arthur Baker, chairman; John Breukelman, Irene Hollenbeck, Robert Smith, and Richard Weaver. Their nominations are presented below. Ballots are being mailed to all NABT members.

Strong officers depend on a concerned membership. Vote now!

■ ■ ■

Candidate for President-Elect

H. Seymour Fowler

Present Position: Associate Professor of Nature and Science Education, Pennsylvania State University, University Park, Pennsylvania.

Degrees: B.S., M.S., Ph. D., Cornell University.

Experience: High school science teacher in schools of central New York. Assistant Professor of Science Education, Southern Oregon College. Assistant Professor of Biology, Iowa State Teachers College. Coordinator of the Pennsylvania State University Center of the AAAS STIP program. Director, NSF Experimental Program in Elementary Science at Pennsylvania State. Participated in NSF Institutes in New York and Virginia.

NABT Activities: First Vice-President (1959). Local Arrangements Chairman for AIBS meetings, 1959. Membership Chairman, Midwest and Middle Atlantic States. National Membership Chairman. Iowa Chairman for Conservation Project. Chairman of Professional Problems Committee.

Organization Membership and Activities: Vice-President, ANSS. NSTA, Fellow of Iowa Academy of Science, AAAS, AIBS, Phi Delta Kappa, Beta Beta Beta, Phi Kappa Phi. Director, Iowa Teachers Conservation Camp. Director of TV programs in "Let's Explore Science" series at Iowa State College.

Publications: Articles in *School Science and Mathematics, ABT, Nature, Science Teacher, Iowa Soil and Water, Soil Conservation, Journal of Educational Research, Midland Schools,* and *Science Education.*

Candidate for President-Elect

Paul V. Webster

Present Position: Biology teacher, Bryan High School, Bryan, Ohio.

Degrees: A.B. (zoology), B.S. in Education, M. A., Ohio State University.

Experience: High school biology teacher for several years. Participant in NSF Institutes at University of Utah, Purdue University, and Indiana University. Instructor at NSF Science Institute at Morehead State College, Kentucky, 1959.

NABT Activities: Secretary-Treasurer (1952-1959). Former Ohio State membership chairman. Active at NABT meetings. Steering Committee for Southeastern Conference on Biology Teaching, 1954, and for North Central Conference on Biology Teaching, 1955.

Organization Membership and Activities: Life member, NSTA. Member: AAAS, AIBS, NEA, CASMT, ANSS, Ohio Education Association. President and Vice-President of Bryan City Teachers Association. Advisor to Future Teachers of America chapter. State parliamentarian of the sponsors of the FTA. Chairman of Williams County Science Teachers Association (1956-1957). Chairman, Science Fair, 1958. Chairman of Bryan Science Fair (1959-1960).

Candidate for First Vice-President

Phillip R. Fordyce

Present Position: Biology teacher, Oak Park and River Forest High School, Oak Park, Illinois.

Degrees: B.S. and M.S. (botany-zoology) Butler University, Indianapolis. Graduate work at Purdue, Colorado, and Indiana Universities.

Experience: High school biology teacher for several years. Active in gifted student studies and the development of the Advanced Standing Biology

Course. Has had five students selected for Jackson Laboratory Precollegiate Program. Sponsor of Talent Search and Science Fair winners. Attended two NSF Institutes at Purdue, and Indiana Universities. Assistant Director, High School Science Student Institute, Indiana University.

NABT Activities: Local chairman for 1957 AAAS meetings, 1958 AIBS meetings, and 1959 AAAS meetings. Membership co-chairman for Indiana.

Organization Membership and Activities: First Annual Science Teacher Award of the Indiana Section of the American Chemical Society. Candidate, Armed Forces Chemical Association, for National Science Teacher Award. State and local Science Fair judge. Sponsor of 200 member Biology Club. Member, AIBS Education Committee. Member, BSCS Committee on the Content of the Curriculum. Consultant for Careers Booklet Project of AIBS. Consultant on Microbiology Unit of the AIBS Film Series. Member, NSTA, CASMT, Northern Illinois Biology Teachers Association. Illinois Junior Academy of Science, NEA, IEA, and the Phi Delta Kappa.

Publications: Articles in ABT on Advanced Biology Course and Study of Protozoology in High School.

Candidate for First Vice-President

Richard T. Wareham

Present Position: Science Book Editor, D. C. Heath and Company, Boston, Massachusetts.

Degrees: A.B., M.Sc., Ph. D., Ohio State University.

Experience: Teacher in Junior High School and Elementary School, Ohio, Science teacher, Clay High School, Ohio. Graduate Assistant in Botany, Assistant, Instructor, Assistant Professor of Botany, Ohio State University. Investigator, U. S. Soil Conservation Service and Ohio Division of Forestry. Inspector of Ohio Seed Improvement Association.

NABT Activities: Participant in Southeastern Conference and North Central Conference on Biology. Served on national programs of NABT.

Organization Membership and Activities: Member, NSTA, Sigma Xi, Gamma Alpha, Gamma Sigma Delta, New England Botanical Club. Fellow, Botanical Club. Fellow, Botanical Society of America, AAAS. Former President, American Bryological Society. Directed study of secondary school education in Weston, Massachusetts. Member, Committee to Visit the Arnold Arboretum.

Publications: Articles in ABT, *The Packet.* Other technical articles on botanical subjects in *American Journal of Botany, Bryologist,* and books concerning mosses.

Candidate for Second Vice-President

Annie Sue Brown

Present Position: Curriculum Specialist in Science, Atlanta Public Schools, Atlanta, Georgia.

Degrees: B.S., Radford College; M.A., (biology), Emory University.

Experience: Teacher of biology and chemistry, Girls High School, Atlanta, Georgia, Shell Merit Fellow, Cornell University.

NABT Activities: Program participant, national meetings. State Chairman, Conservation Project. Local Chairman, AAAS meetings in Atlanta. Participant, Southeastern Conference on Biology Teaching.

Organization Membership and Activities: Member, Phi Sigma, Delta Kappa Gamma, Kappa Delta Epsilon, Alpha Zi Delta, NSTA, NARST, AAUW. Fellow, Georgia Academy of Science, AAAS. Councilor-at-large, Georgia Academy of Science. Assistant Director, Georgia Science Curriculum Workshops. Woman of the Year in Education and Woman of the Year, Atlanta. Winner of the Armed Forces Chemical Association's award as outstanding science teacher of the year. Member of Committee of text advisors, AIBS Film Series. Regional Director, NSTA.

Publications: Articles in professional magazines on science teaching. One of the authors of film, *Biology of The Frog,* Indiana University.

Candidate for Second Vice-President

Phyllis S. Busch

Present Position: Adjunct Associate Professor, Science Education, New York University.

Degrees: Ed.D., New York University.

Experience: Master teacher, biology, Harvard-Newton Summer School. Instructor, Brooklyn College and Queens College. High school biology teacher, New York City.

Organization Membership and Activities: Member, AAAS, Linnaean Society, NSTA, New York City Teachers of Biological Sciences, New York City Federation of Bird Clubs, Torrey Botanical Club, Ecological Society of America, ANSS. Recipient, FSA Teacher Recognition Awards for two years. Received Liberty Hyde Bailey Medal for contribution to conservation education.

Publications: Articles in ABT, *The Science Teacher, The Teaching Scientist*, and *Metropolitan-Detroit Science Review.*

Candidate for Third Vice-President

Robert L. Smith

Present Position: Chairman, Biology Department, DeKalb High School, DeKalb, Illinois.

Degrees: B.E., Illinois State Normal University, M.A., (zoology), University of Michigan.

Experience: Biology teacher and coach, Illinois high schools. Teaching Assistantship, University of Michigan. Parasitologist in Armed Services.

NABT Activities: State and Regional Chairman, Conservation Project. National Membership Chairman since 1955. Participant North Central Conference on Biology Teaching.

Organization Membership and Activities: Illinois Junior Academy of Science, State Chairman.

Publications: NABT Conservation Handbook.

Candidate for Secretary-Treasurer

Herman C. Kranzer

Present Position: Assistant Professor, Science Education, Pennsylvania State University, University Park, Pennsylvania.

Degrees: B.S., (forestry), M.A., (education), University of Michigan; Ed.D., U.C.L.A.

Experience: Taught science and conservation, Work-Learn Camp for Older Youth, Michigan; Teacher-counselor, Clear Lake Camp, Battle Creek Schools. Outdoor Education Director, Culver City, California. Director, Conservation Education Laboratory for Teachers, Pennsylvania State University.

Organization Membership and Activities: Member, NSTA, Pennsylvania Science Teachers Asociation, Conservation Education Association, Phi Delta Kappa. Board of Directors, Pennsylvania Forestry Association.

Publications: Education in the Out-of-Doors, Pennsylvania School Study Council. Bulletin of the Michigan Secondary School Association. *A Community School Work-Learn Camp*, Michigan Department of Public Instruction.

Candidate for Recording Secretary

Joan Hunter

Present Position: Biology teacher, West Senior High School, Aurora, Illinois.

Degrees: B.E., Eastern Illinois University; M.S. (botany), University of Michigan.

Experience: Seventeen years biology teaching at Edwardsville, Illinois, prior to Aurora post. Participant in NSF Baylor University Institute, 1958, and Westinghouse Fellow at MIT, 1951. Nature counselor for 4-H camps in Illinois. Extensive travel.

NABT Activities: Has served on national programs of NABT. Membership Committee.

Organization Membership and Activities: Member of Kappa Delta Pi, Delta Kappa Gamma, NSTA, AAAS, IEA, NEA, and Illinois Academy of Science. In June, 1958, Southern Illinois University presented the Distinguished Service Award. State Chairman, Illinois Junior Academy of Science. Only high school teacher to be elected President of the Illinois Academy of Science (1956-1957). Member, St. Louis Science Fair Committee. Has appeared on programs of NEA, NSTA, and AAAS. Member, Illinois Curriculum Committee. Reviewer for AIBS Film Series.

Publications: Articles in professional magazines.

Candidate for Recording Secretary

Joseph D. Novak

Present Position: Assistant Professor of Biological Education, Purdue University.

Degrees: B.S. (science teaching), M.A., (education), Ph.D. (science education), University of Minnesota.

Experience: Research assistant and teaching assistant, Botany Department; Instructor of Botany, University of Minnesota. Assistant Professor of Biology, Kansas State Teachers College.

NABT Activities: Participant at North Central Conference on Biology Teaching, 1955.

Organization Membership and Activities: Member of Sigma Xi, Botanical Society of America, Phi Delta Kappa, NARST, Minnesota Academy of Science, Kansas Academy of Science, Society for General Systems Research, Association of Midwest College Biology Teachers, Indiana State Teachers Associa-

tion, National Council on Measurements used in Education, American Educational Research Association, and CASMT. Fellow, AAAS. Chairman, Committee on Educational Trends, Kansas Academy of Science.

Publications: Journal of Experimental Education, Proceedings of the Minnesota Academy of Science, Transactions of the Kansas Academy of Science, Science Teacher, and *Science Education.*

Book Reviews

THE AUTOBIOGRAPHY OF CHARLES DARWIN AND SELECTED LETTERS, edited by Francis Darwin, 365 pp., $1.65, Dover Publications, Inc., New York, 1959.

A republication of Darwin's Autobiography together with a number of important letters.

FRUIT KEY AND TWIG KEY, William M. Harlow, 56 pp., $1.25, Dover Publications, New York, 1959.

An illustrated key for identification of the fruit and twigs of trees and shrubs of the Northeastern states.

LIVING EARTH, Peter Farb, 178 pp., $3.75, Harper and Brothers, New York, 1959.

An interesting account of the variety of animals and plants that live in the soil. Attention is focused on three types of soil environment, the forest, grassland, and desert. The communities of life of each area are discussed. The biology and interesting habits of many forms are considered. Written in an interesting manner, it will be enjoyed by high school students.

CRIME AND INSANITY, edited by Richard W. Nice, 280 pp., $6.00, Philosophical Library, New York, 1958.

When shall a man be held legally insane—and thus escape the punishment dealt out impartially to his more "normal" brothers-in-crime? In the field of criminal law, this problem is not new, but in the light of the contributions made by modern psychology to our shifting concepts of moral guilt and legal responsibility, it grows daily more acute in our courts. This symposium by 12 experts in jurisprudence, psychologists, prison psychiatrists, educators and sociologists, was prepared to bring this most serious of judicial problems into sharper, more realistic focus.

JUVENILE DELINQUENCY, edited by Joseph S. Roucek, 370 pp., $10.00, Philosophical Library, New York, 1958.

This survey by 14 well-known specialists in the field offers a systematic evaluation of the available experience in the whole area of juvenile deliquency, including the various theories of its causes, and the many attempts at its prevention and correction. The treatment concludes with two studies on the unmistakable international trends in juvenile deliquency.

HANDBOOK OF TOXICOLOGY, VOLUME V, FUNGICIDES, Barbara L. Tuma and Lucy C. Lee, 242 pp., $5.50, The National Academy of Science, The National Research Council, W. B. Saunders Company, Philadelphia, 1959.

This volume presents pertinent information concerning 196 substances which have fungicidal or fungistatic activity. In addition to molecular and structural formulae, physical and chemical properties, and usage, data concerning effects on specific organisms are given as well as the toxicity of these agents to man and animals. An appendix lists more than 500 additional fungicidal compounds with relevant bibliographic citations. This compilation should prove a valuable guide to the literature for mycologists, especially to plant pathologists and medical mycologists, since many of the data are not readily available elsewhere. A number of the references are to (frequently unpublished) studies by private industry, individuals, and various governmental agencies. An index to the fungi affected is not included. Such an index with cross-references to text and bibliography would have been a valuable addition. Despite this disadvantage, this volume seems useful enough to warrant publication of periodic supplements. These might be less elaborate than the original, consisting of check lists of compounds and of fungi cross-indexed to a bibliography.

Robert Johns, Indiana University

HANDBOOK OF TOXICOLOGY, VOLUME III, INSECTICIDES, William O. Negherbon, 854 pp., $14.00, The National Academy of Sciences, The National Research Council, W. B. Saunders Company, Philadelphia, 1959.

This is primarily an exhaustive reference work on chemical materials used as insecticides, but it contains a considerable amount of information on the biology of insects which is made available through an excellent index. An interesting introduction by Negherbon gives an outline of the methods of applying and testing insecticides and a number of useful definitions. The remainder of the work is a list of chemical materials from ACRONITRILE to WILFORDINE. Each material is named, its physical and chemical properties described, and the structural formula given if known. The toxicology, phytotoxicity, toxicity to insects, and other properties are presented by means of comparative tables and references. A list of over 3,400 references, an index to scientific and common names of animals referred to in

tables or discussions, and an index to chemical compounds treated complete the volume.

Frank N. Young, Indiana University

THE GANG: A STUDY IN ADOLESCENT BEHAVIOR, Herbert A. Bloch and Arthur Niederhoffer, 231 pp., $6.00, Philosophical Library, New York, 1958.

The authors have described and analyzed in great detail the behavior of adolescents in a variety of cultures. They indicate the sociological and psychological reasons for the organization of adolescent groups; the ambitions, objectives and ideals these try to serve; and why such groups become subverted into predatory gangs in certain societies.

EPILEPSY, Manfred Sakel, 204 pp., $5.00, Philosophical Library, New York, 1958.

This book is presented as a great doctor's last contribution to medical literature—an intriguing medical document and a fitting monument to the life work of a noble pioneer. Part One deals with symptomology of epilepsy, forms of symptomatic epilepsy, predominant causes, pathogenesis and etiology, currently employed therapy, and the role of physical exercise as a therapeutic factor in the management of epilepsy. Part Two is the theory and method of curing epilepsy proposed by Dr. Sakel.

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